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VOLUME XXVIII SAN FRANCISCO, JANUARY 27, 1912 NUMBER 4

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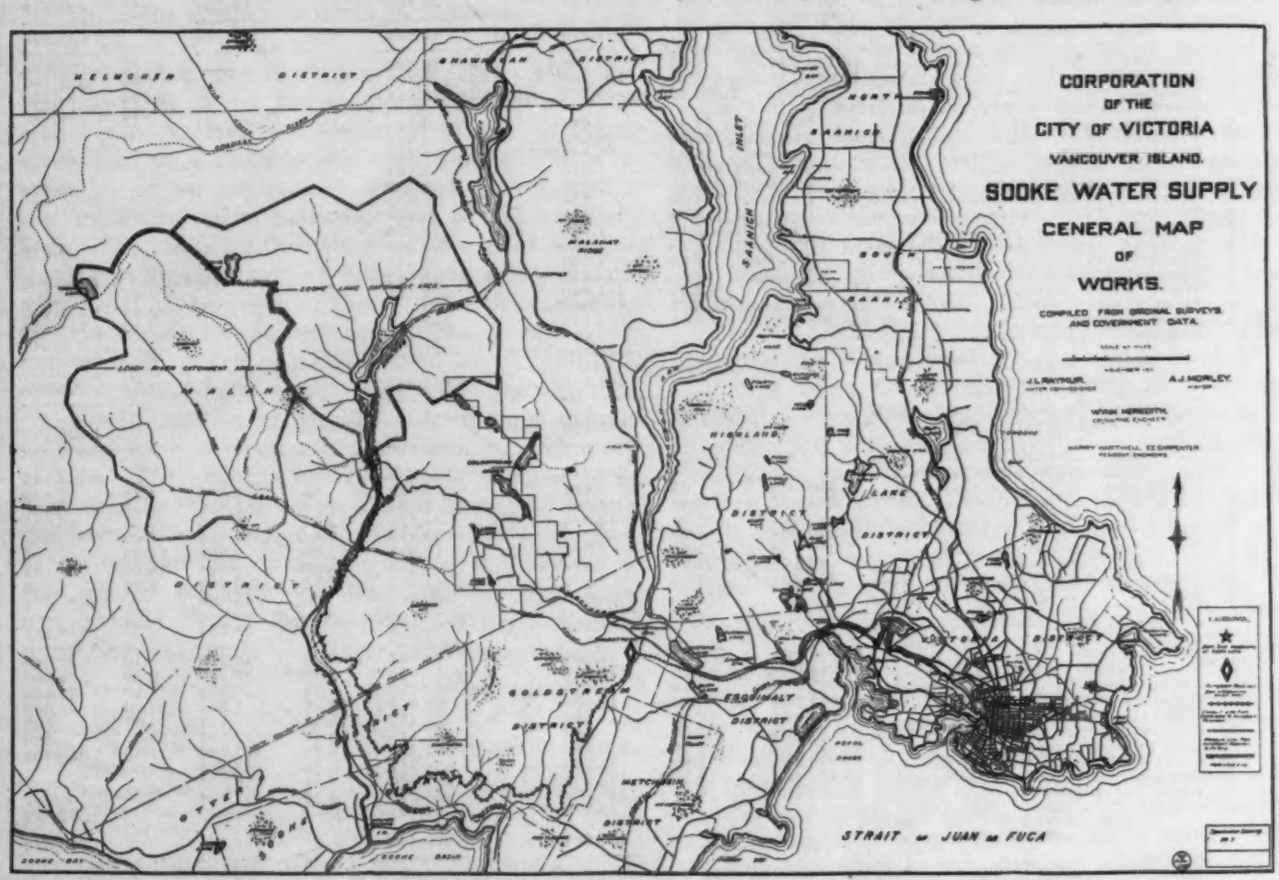
THE SOOKE WATER SUPPLY SYSTEM

The water supply system for the city of Victoria, British Columbia, for which the contracts are now being drawn, has many interesting details. The general scheme that the work contemplates is the utilization of the waters of Sooke Lake, which lies in the Malahat District to the northwest of Victoria about 18 miles. The piping system will convey 16 million imperial gallons of water daily from Sooke Lake to the present mains of the city.

The present elevation of the lake is 655—Victoria datum—or 555 feet above sea-level. The lake level will be raised 12 feet by means of a concrete and earth-filled dam at the southern end of the lake, affording by this means a storage of over 13,000 acre feet. The catchment area tributary to this source is about 31 square miles, and the average annual rainfall 70 inches.



Map of Sooke Water Supply System, about to be constructed, showing relative positions of the Sooke Lake Catchment Area, the Lake with dam and headworks at southern extremity, conduit line to Humpback Reservoir and pressure line to Victoria. Sooke Basin and the Canadian Northern Pacific Railway, now under construction, will offer shipping facilities.

From the lake to the pressure reservoir, near Goldstream, there will be constructed a reinforced concrete pipe, 40 inches in diameter, laid on a grade approximately 1 foot in 1000. The pipe will be 24 miles in length and extremely crooked. It will be without pressure, and will empty into Humpback Reservoir at

elevation of 495. From this elevation the water will cascade into the reservoir, which will have its normal full level at elevation 480. This pressure reservoir will contain approximately 130 million imperial gallons, and to retain this quantity there will be constructed a concrete dam containing 8000 cubic yards, and 400 feet in length, with a maximum height of approximately 50 feet above bedrock. Passing through the headworks and a large Venturi meter, the water will enter a 36-inch riveted steel pipe to be conveyed to the city, where a connection will be made to the existing distributing system.

The specifications for the work were turned over to the City Council on November 1st of last year by Wynn Meredith of the engineering firm of Sanderson & Porter. No untried or experimental features are included, and designs of a highly ornamental, or expensive character, have been avoided, the utilitarian features receiving first consideration. The construction provided for is of a substantial character, as it should properly be for municipal works.

No provision has been made for covering the flow line conduit between Sooke Lake and the Humpback Reservoir as a protection against freezing. Such pro-

		DESCRIPTION.	Quantity.	Unit Prices.	Successful Bidder Lump sum.	Average Bidder Unit price.	Average Bidder Lump sum.	Partial Bidder Unit price.	Partial Bidder Lump sum.	Engineers' Estimate Unit price.	Engineers' Estimate Lump sum.
A.	1.	Excavating drain channel, earth	100 yds.	$1.50	$150	$1.40	$140	$0.83	$83	$1.60	$160
	2.	Excavating drain channel, rock	350 yds.	7.50	2,625	4.20	1,466	3.30	1,155	3.00	1,050
	3.	Clearing	300 ac.	150.00	45,000	276.00	82,833	135.00	40,500	250.00	75,000
	4.	Clearing submerged	80 ac.	250.00	20,000	242.00	19,374	135.00	10,800	200.00	16,000
	5.	Wagon road	11,600 ft.	1.50	17,400	1.14	13,237	1.04	12,064	1.10	17,000
	6.	Haleys bridge			500		510		600		1,200
		Total Schedule "A"			85,675		117,560		65,202		110,410
B.	1.	Dam exc., earth	2,400 yds.	.70	1,680	1.08	2,600	.66	2,554	1.00	2,400
	2.	Dam exc., rock	1,300 yds.	4.75	6,175	3.94	5,110	3.00	3,900	2.00	2,600
	3.	Concrete in foundations	520 yds.	11.00	5,720	11.40	5,954	9.00	4,680	15.00	7,800
	3.	Concrete in foundations	10 yds.	15.00	150	15.30	153	11.00	110	15.00	150
	3.	Concrete in foundations	10 yds	13.00	130	13.20	132	10.00	100	15.00	150
	4.	Dam and intake			30,000		30,065		19,400		28,259
		Total Schedule "B"			43,855		44,014		30,744		41,359
C.	1.	Exc. earth, pipe bed	26,500 yds.	.60	15,900	.79	20,905			.76	20,190
	2.	Exc. rock	69,000 yds.	1.75	120,750	2.43	167,823			1.90	131,100
	3.	Clearing right of way	23 mls.	2,400.00	55,200	1,900.00	43,764			1,495	34,375
		Clearing right of way								652	15,000
	4.	Trestles, 5-ft. bents	Per bent,	52.00	2,080		3,125				
	4.	Trestles, 10-ft. bents	Per bent,	60.00	3,000		4,745				
	4.	Trestles, 15-ft. bents	Per bent,	80.00	1,120		1,656				55,319
	4.	Trestles, 20-ft. bents	Per bent,	100.00	1,200		1,782				
	4.	Trestles, 25-ft. bents	Per bent,	140.00	1,120		1,469				75,000
	4.	Trestles, 30-ft. bents	Per bent,	180.00	720		882				
	4.	Trestles, 35-ft. bents	Per bent,	215.00	430		481				
	5.	Culverts, 12-inch	Per foot,	1.10	1,540		2,478				
	5.	Culverts, 24-inch	Per foot,	3.20	2,880		3,560				8,000
	5.	Culverts, 40-inch	Per foot,	6.00	3,000		3,472				
	6.	Ravine crossing	150 Each,	97.00	14,550		16,683			Included in trestles.	
	7.	Wood stave pipe	118,000 ft.	2.47	241,460		573,726			3.67	433,365
	8.	Steel riveted pipe	120,000 ft.	5.25	660,000					9.61	1,152,940
	9.	Concrete pipe	125,000 ft.	2.53	316,250		566,944			4.15	516,710
	10.	General			7,000		10,534				9,280
		Totals Schedule "C" with wood stave pipe			471,950		857,085				706,629
		Totals Schedule "C" with steel riveted pipe			890,490						1,426,204
		Totals Schedule "C" with concrete pipe			546,740		850,303				809,655
D.	1.	Earth exc.	5,300 yds.	.65	3,445		5,412	.85	4,505	1.50	7,950
	2.	Rock exc.	750 yds.	4.00	3,000		2,391	2.20	1,650	3.00	2,250
	3.	Clearing reservoir	40 ac.	350.00	14,000		19,445	75.00	3,000	300.00	12,000
	4.	Gravel bottom	10,000 yds.	1.00	10,000		17,845	2.00	20,000	1.00	10,000
	5.	Concrete foundations	200 yds.	12.50	2,500		2,616	11.00	2,200	15.00	3,000
	5.	Concrete, Class "B"	10 yds.	10.00	100		110	9.00	90	10.50	105
	5.	Concrete, Class "C"	500 yds.	9.25	4,625		4,578	7.50	3,750	8.00	4,000
	6.	General			33,000		90,881		15,000		107,276
		Total Schedule "D"			70,670		143,278		50,195		146,581
E.	1.	Earth trench	54,000 yds.	.60	32,400		42,066	.75	40,500	.70	37,800
	2.	Rock trench	10,000 yds.	3.00	30,000		31,810	3.00	30,000	3.50	35,000
	3.	Trench backfill	50,000 yds.	.15	7,500		16,250	.50	25,000	.50	25,000
	4.	Concrete piers, Class "B"	600 yds.	20.00	12,000		9,072	12.50	7,500	20.00	12,000
	4.	Concrete piers, Class "A"	10 yds.	20.00	200		173	15.00	150	20.00	200
	4.	Concrete piers, Class "C"	10 yds.	18.00	180		115	10.00	100	15.00	150
	5.	Lap welded pipe	54,000 ft.	7.00	378,000		477,600	8.25	445,500	7.15	385,904
	6a.	Steel riveted, 5/16-inch	19,000 ft.	5.25	99,750		156,777	8.85	168,150		
	6b.	Steel riveted pipe, ⅜-inch	35,000 ft.	6.25	218,750		327,700	9.90	346,500		
	7.	Lock bar pipe	54,000 ft.	6.80	367,200		448,500	8.10	437,400		
	8.	General			22,000		32,408		60,000		27,490
		Totals Schedule "E" with lap welded pipe			482,280		609,494		608,750		523,544
		Totals Schedule "E" with steel riveted pipe			422,780		616,371		677,900		
		Totals Schedule "E" with lock bar pipe			471,480		580,394		600,650		
					Sum of Schedules	Tender F.	Sum of Averages.				
F.		Wood stave and lap welded			$1,154,430	1,154,430	1,771,431				1,528,544
		Wood stave and riveted			1,094,930	1,094,930					
		Wood stave and lock bar			1,143,630	1,143,630	1,778,308				
		Concrete and lap welded pipe			1,229,220	1,229,220	1,764,649				1,631,549
		Concrete and riveted pipe			1,169,720	1,169,720	1,771,526				
		Concrete and lock bar			1,218,420	1,218,420	1,735,549				

December 20, 1911.

tection is, it is believed, unnecessary, and on account of the scarcity of material available, would prove somewhat expensive, but should it be found needful at a later date, the cost would be no greater than at present. Experience with the open flume of the Jordon River development of the British Columbia Electric Railway Company, during last winter, confirms this opinion. This flume is located at a higher elevation, and subjected to more severe conditions, than will prevail on the flow line conduit, and little or no difficulty was experienced in maintaining a continuous flow of water throughout the winter. Necessarily, standpipes, air valves, relief valves and fittings will be enclosed in wooden boxes and packed with sawdust for frost protection.

The subdivision of the contract into different schedules was made with a view of obtaining separate tenders upon various parts of the work. The division into schedules is a natural one, by virtue of location and the different classes of construction and materials required, and has resulted in obtaining tenders from responsible contractors experienced in the respective classes. Schedule F combines and includes in one tender all of the work and items in Schedules A, B. C, D and E.

Bids were opened for the contract on December 15th and the firms below submitted tenders. No tender was received and deposited by the city unaccompanied by a certified check for $15,000. With the awarding of the contract all checks were returned to the respective tenderers except that of the successful firm. The check of the latter was returned with the signing of the contract and filing of the required bond, which was 10 per cent of the contract price to guarantee a satisfactory completion of the work. A forfeiture of the check of course would have obtained in case the bidder failed to enter into the agreement.

The quantities in the schedule are approximate only and were given as a basis for uniform comparison of bids. The quantity of any class or portion of the work may be increased or decreased as may be deemed necessary by the engineer. An increase or decrease in the amount of excavating or in the amount of masonry or concrete will not alter the unit prices nor the time allowed for completion of the work.

The rate of progress prescribed is shown thus:

Three months	6%	of work	completed.
Six months	15%	"	"
Nine months	45%	"	"
Twelve months	55%	"	"
Fifteen months	65%	"	"
Eighteen months	80%	"	"
Twenty-one months	95%	"	"
Twenty-four months	100%	"	"

The contractors who tendered bids are: The Westholme Lumber Co., Victoria; The Graff Construction Co., Seattle; Naylor Bros., Vancouver; Norton, Griffiths & Co., Ltd., Vancouver; Holf & Jeffrey, Seattle; Victoria Machinery Dep., Porter Bros., Victoria; Geo. C. Deitrich & Co., Seattle; Sound Construction Co., Seattle, and P. J. McHugh, Seattle.

The contract, including concrete flow line pipe and riveted steel pressure pipe, was awarded to the Westholme Lumber Company at the price of $1,169,720. This sum is shown segregated among the various items in the accompanying table, which also shows the Average of Tenders, the Engineer's Preliminary Estimate and the Completion Requirements.

The by-law authorizing this contract was approved by the taxpayers at the General Municipal Election held January 11, and there is every reason to expect the work to proceed at once.

Sooke Harbour offers many facilities for delivery by water of materials and supplies adjacent to part of the work, and the Canadian Northern Pacific Railway will offer similar service. This railroad is now in process of construction from Victoria north along Sooke River, approximately paralleling the flow line conduit from Sooke Harbour to the lake. The grading of this line is now completed to within about 1½ miles of Sooke Lake and it is probable that the track will be laid early this year.

THE PROPOSED MAMMOTH WIRELESS TOWER.

The Memorial Tower, the construction of which has been endorsed and approved by the Board of Directors of the Panama-Pacific International Exposition, has become of world-wide interest, on account of the wireless possibilities. If the shaft is placed in Lincoln Park and a wireless station installed in the tower, it will make San Francisco the highest-powered station in operation and will produce long distance results hitherto considered impossible, placing San Francisco in direct communication with Washington, Key West, Colon, Honolulu, all Alaskan stations, vessels in the Pacific, and possibly with stations on the coast of Japan.

A letter received from George von L. Meyer, Secretary of the Navy, says:

"The Navy Department is taking steps towards erecting a high-power station on the California coast, in connection with its chain of wireless stations across the Pacific, and for communication with ships in the eastern Pacific Ocean. Since the range of wireless depends principally upon the height of the aerial wires above the ground, and since the location of this station at San Francisco would be most advantageous to that city, it would seem that the Memorial Tower should be erected with a view to its use for supporting one end of an aerial of the most powerful wireless station in the world. The Eiffel Tower in Paris, 1000 feet high, has produced wonderful results in long distance wireless work, and the proposed tower, 1350 feet above sea level, would insure even more remarkable results.

"A site near the ocean beach at San Francisco will give ideal wireless conditions, there being no tall buildings or trees in the sending direction, and I strongly recommend that, before the exact site of the Memorial Tower is selected, the Navy Department be consulted as to the needs of the proposed wireless station. Such a station would in no way interfere with the use of the tower as an observation station for visitors, or for its use as a weather station. The small wires of the aerial could not detract in the slightest from the appearance of the tower, while adding greatly not only to its utility, but to its attractiveness for visitors."

EVOLUTION VS. REVOLUTION IN PUBLIC SERVICE.[1]

BY T. B. COMSTOCK.

As in most of the so-called revolutions of history, the reform substituted for the earlier regime is but a grafting of new ideas upon old stock.

There was plausibility which went far to excuse the visible methods of the trusts in destroying competition, and there might have been a longer and a brighter epoch of consolidation had only the brainy chiefs of the new system been able and willing to demonstrate practically the real merit of their scheme by an equitable distribution of the gains, through lowering of prices, or even by measuring capitalization on the basis of actual investment. But there is another point of view which the mass of the people are not prone to regard. The power acquired to set the price of the necessities of life through the ownership of public utilities and the control of production and distribution did not come by chance, nor by simple annihilation of competition. It was as much due to risks taken by the lambs of the people in speculating in over-valued securities and to their failure to get orthographic projections of the perspective presented. Now that the public spirit is awakening, there is grave danger that it will be led astray as far in the opposite direction by the counsels of such as know no antidotes for poison save drastic emetics.

If the people had not been implicated in the deal by their participancy in the transactions in Wall Street their case would have become more a matter of legitimate business and much less a football for office-seeking politicians than it appears today.

Gradually, but slowly, we are approaching better conditions, thanks to the calm and patient work and self-sacrifice of those who care only for the reward that comes from consciousness of well-doing. And I can say to you, fellow engineers, that the hope for the future which no untoward event can drive from me, is dependent upon the firm conviction due to abundant experience, that the courts and the lawyers, on both sides of these public questions, have already gone about as far as is possible along the lines of action demanded by the theory of their profession.

I have so often compared notes with other engineers, and have had so much benefit from their well earned opinions, that I feel warranted in asserting that the solution of the economic problems of the coming days must eventually be recognized as fittingly and peculiarly adapted to the engineer's field of labor.

There are two elements of danger to the life of any profession. One is the pride of cult which may come from the culmination of authority. The other is the ultra-conservatism which is liable to result from the clannish spirit developed.

The profession of engineering is now established by the justification of itself by its works in many branches of construction and operation. There are partisans and charlatans, too, in our own ranks, who do not scruple to veer with the breeze which blows most money or other sordid gain to their hand. They are products of the same unprofessional systems which, by association with degraded trade methods, have honeycombed the better recognized professions with corrupt practices.

These dangers have been largely forestalled by better methods of applying engineering testimony in the deliberations of boards directly concerned in the regulation of public service. New York, Wisconsin and other States have set the mark in this particular, and nearly all the civic powers engaged in this duty have permanent staffs of engineers employed.

Reports of these various commissioners show clearly that at least from 2/3 to 4/5 of the scope of work performed consists of matters which require reference to engineers in first instance. And the largest proportion of these are decided upon rulings formulated by the engineering staff.

It could not well be otherwise, when the engineering character of the service is duly considered. And it is gratifying to observe that the decisions of engineering questions and matters of accounting which have been adjudicated by the several boards, on the advice or by direct ruling of the engineering corps, have almost always been identical where equivalent principles have been involved.

The need of public regulation of public service is apparent to all who have given close attention to the abuses which have grown out of loose and venal methods of handling such business. And this need is recognized and freely admitted by the most capable of the managers and staffs of the operating companies themselves. Between the attitude of him who was reported as saying "The public be damned," and the agitator who would counsel destruction of the plant as a source of relief from corporate greed, there is a mean line of equal justice to which both the public and the corporations should be brought as speedily as possible. There never will be complete and satisfactory public service until this be accomplished in a spirit of friendly co-operation. And it is a matter of very great moment at this juncture to have this done intelligently and permanently, so that its practical success may be demonstrated and its continuance guaranteed.

The conditions existing in Los Angeles are peculiar and not well adapted to the immediate application, in toto, of a plan based upon an ideal situation. It would be much simpler and more facile in regulation to have each utility monopolized by one corporation, instead of two or three companies of each kind serving the same territory.

But we have to consider that the competition, which is really incompatible with the theory of regulated monopoly, the very plan adopted for overcoming the evils of competition—was fostered and extended by the people for the purpose of obtaining just what the new plan is now supposed to ensure.

The best way is to let "Nature take her course," and this has already resulted in such rearrangement of the transportation service as to accomplish, at least on paper, the realization of the ideal. That is to say, the local lines may now all be regarded as one monopoly unit, ostensibly, and all the interurban lines as another unit monopoly.

So, from construction and operating standpoints,

[1]Abstract from paper presented Dec. 19th, 1911, before the A. I. E. E. and Engineers' & Architects' Association, Joint Meeting, at Los Angeles, Cal.

regulation is becoming more practicable than would have been possible formerly. But the gridiron has grown with the expansion of the city without much reference to any general plan for the future. With a much greater number of cars per mile of track than other cities, the distribution of traffic is such as to cause serious congestion in rush hours, in many parts of the business district. Attempts to overcome this piecemeal have been about as futile as to try to tickle a mule in the flanks without making him kick, or to catch an agile fly.

The only way out of the puzzle is to earnestly and persistently watch the traffic and study its statistics, making direct crossings of streets as far as possible to eliminate curves and routing cars over looped circuits to avoid obstruction of streets by trolley turnings.

The problems which confront officials charged with the duty of regulating public service in the hands of private corporations, are not very different from those which constantly beset these operatives themselves. Sometimes the registering of a complaint with a city board may expose a blemish or a deficiency of service which had not been previously noticed or regarded as important by the railway officials. Occasionally honest difference of opinion may result from investigation from both sides, and there may be necessity for ruling against the contention of the company's representatives. Again, it may happen that a tentative judgment of the regulating body will be found inapplicable after consideration of more evidence produced by the company.

There may be short periods of excited public feeling when all considerations of justice appear to be thrown to the winds. It is quite as much to the people's interest in the long run that they be protected from untoward results of their own ignorance or imprudence as to be guarded from purely selfish aggression on the part of the utility corporations.

No member of the board or any of its officials should be chosen or retained in position unless he be fully capable of sifting evidence, of character unimpeachable, without any interests or political aspirations which may prejudice him for or against one side or the other in advance of specific investigation. He must of necessity refrain from investment and from advising others on investments in public utilities or securities in any way related to the business amenable to his jurisdiction. He ought to be one of ripe years of experience in construction, operation and executive work, with practical knowledge of the principles involved and of the sources of supply, the forces utilized and the requirements of the service which he undertakes to supervise.

The average politician, and sometimes the appointing power itself, is incompetent to select even if there be intent to select, just the proper persons to sit in judgment upon questions which require intimate acquaintance with details and adequate knowledge of the relations of parts in operation.

Unless politics, in the sense of wire-pulling, intrigue and partisanship, can be absolutely divorced from the regulating board, it will be futile to hope for results that will satisfy.

The pecuniary stipend of such men as are qualified will have to be placed far above the ordinary allowance, or the incumbents must be sought among those who, with equivalent earning capacity, are so situated that they may afford to serve regardless of the remuneration offered.

There are three methods of supervision in effect in the United States outside the scope of the Inter-State Commerce Commission, which is not included in this discussion.

New York State, Massachusetts, Wisconsin, Washington State, California (just beginning) and other States and cities have boards of from 3 to 23 members, who are given varying degrees of jurisdiction over more or less restricted range of service.

Some cities, like Los Angeles, Chicago, St. Louis, Kansas City, Boston, Baltimore and others, have boards, usually of three members, whose jurisdiction and degree of control and initiative are not strictly comparable. There is no uniformity of powers or methods in this class.

In many cities, as Des Moines, Seattle, St. Louis, etc., the so-called commission form of government has been adopted in many varieties of expression. So far as the public service regulation is concerned, in the majority of these last instances, one man is the responsible executive head of a bureau, charged with powers and duties of autocratic nature, and subordinate to the council of similar chiefs, of which he is a member.

All of these commissions are ostensibly intended to meet the popular demand for one and the same principle in government. They are, however, about as widely divergent as if born of unrelated conceptions. This result is due more to differences in State Constitutions and local city charters than to intentional variations in practice. Some are wholly experimental, their continuance probably as much dependent upon the personnel of the incumbent officials as upon the method of action prescribed.

One great obstacle in the way of speedy and correct solution of our public service problems is the lask of understanding of perspective, the inability of many people, including ordinary citizens, and some public officials and coporation managers, to measure things as they are, instead of as they may appear at different distances and from a single point of view. The training of the architect and the engineer and his habit of work lead him to prepare perspective drawings for his public; but his files of working plans are drawn in orthographic projection, his constructive and operative work are based upon combinations of many perspective views.

Transportation is the most complex and most important, and at the same time the real fundamental issue in the regulation of public utilities. It demands most capital, most concessions and privileges from the community and it is most essential to the inhabitants in their daily movements for all purposes. The location and development of industries, the filling up of residence districts with homes, the character and extent of a city's growth, the distribution of parks, school houses, churches, theatres and various other accessories are wholly dependent upon the layout of the traffic arteries, and no acceptable or effective city plan can be laid out independently of these.

If all railways of every kind within the city limits were to be operated by electricity, as is, perhaps imminent, the casual observer might regard them as of one class. Until recently, it was customary with some degree of propriety to segregate them in two groups as steam and electric. But now it is daily becoming more necessary to make three main divisions, and probably some six subdivisions will be recognized as essentially distinct in regulation before very long. This complete list comprises:

Divisions.	Sub-Divisions.
1. Trunk Line	A. Passenger
	B. Freight
2. Inter-Urban	C. Rapid Transit
	D. Accomodation
	E. Express-Freight
3. Inter-Mural	F. Local Passenger

Within the past year significant changes of technical ownership and management have occurred which have left the situation ostensibly as here presented. But I am not sure that this classification in detail is in strict accord with the designs of those in control of the destinies of all the operating lines, nor can I predict with surety what changes may be wrought by legislation under influence of those who may be in authority in the city government for the next five years.

The grouping here given, is based upon close study of the history of the development of the transportation systems for nearly fifteen years and upon two years of daily experience with the necessities and short-comings of the unwieldy status quo.

The status of the interurban service is far from satisfactory from the standpoint of the city or of the company. It is a nice problem in engineering economics, and there are others connected with local service which cannot be solved by juggling with them, nor will they be settled without patient forbearance and co-operation on the part of the public and the corporations interested.

There are two methods of approaching and handling the railway situation in Los Angeles, now, that we have fairly well ascertained what is the matter with the mix-up. City officials and the corporations may work together in harmony, but independently in acquiring adequate knowledge of facts and in comparing notes and striving to adjust differences amicably, even at some sacrifices of acquired or inherent rights. Or each party may stand upon the letter of the law and quibble and quarrel until one or other (or possibly both) be beaten in the contest. Which is the better way in the estimation of those to whom the work is entrusted on either side may be dependent largely upon the training and experience of the arbitrators. My observation shows that the training of the engineer best fits him to meet the issues, because, if he be worthy his profession, his first and greatest ambition must be to get at the facts, and then to adjust matters for the economical working of the machinery and the prevention of waste.

There are corporations and corporations. All cannot be treated alike. Some deserve respect, others need coercive treatment. Only one who knows the difference between the two classes is capable of attacking his problem intelligently. Mutual respect between officials of the city and the corporation is an excellent working asset for both. But this cannot be maintained unless both are sincere.

A gentleman with moderate business experience in retail merchandising was asked to assume the position of general manager of one of the largest mining companies in Colorado. He modestly dclined on the ground that he knew nothing of the business. The reply was "All you need is to get a good foreman, and you can handle it as well as anybody." Too many corporations thus do manage with ANY body as the nominal head.

Another very important enterprise was in control of a man who had no practical knowledge of the business and was without training. At his death, his most efficient skilled lieutenant succeeded him. In one year the reduction of costs, increase of output, stoppages of waste and improvements made, completely revolutionized affairs. The new manager had become pecuniarily worth hundreds of thousands of dollars to the corporation.

In another case, a trained and careful manager resigned, because he was offered an increase of salary by another corporation. He was succeeded by an accounting officer who judged results by the books alone. He had a hobby, and proceeded to demonstrate that greater saving of metal was possible than had ever been shown by his predecessor. The result in net earnings the first year was a decided gain, and his slags were cleaner. Proud of his supposed achievement, he gave way to a man familiar with the "kraft and stoff" of the art, who shortly found that the furnace linings required renewal, (the lack of reworkable slag for mixtures demanding higher heat) and that the reserve supply of fuel purchased in prior years, was almost exhausted, while the plant in general had been greatly damaged. At the same time, no outlay for opening new ground had been incurred and repairs had not been kept up. The books and the pockets of stockholders showed increased net earnings; but the net results were on the other side of actual profit and loss.

One railroad company was officered by capable men, constructing and operating engineers, in effect, but these were dominated by the legal staff and manipulators of securities, who were engaged in the process of wrecking the plant for ulterior purposes. You probably know how that turned out as a business organization.

There is a gigantic system of operations conducted by a public utility corporation, whose attorneys are noted for keeping out of litigation and amicably adjusting difficult situations. But the active management and control rest with an untrammeled engineering staff, whose record is superb for low cost and high quality of output under stringent regulations as to rates and conditions of operation.

Now I think you must have already made due application of the significance of these facts in their bearing upon the right regulation of public service. And please bear in mind that the public and its officers can go as widely wrong in their conclusions as to adequate rates and reasonable privileges and restrict-

ions as the owners and operators of the plants which furnish the necessities of life. Public ownership, if it be successful, pre-supposes efficient management, and this cannot be secured by election or appointment of responsible officials without knowledge of the work they are permitted to supervise.

There are two dangers lurking in the appointment of utility boards, and the fixing of rates and regulation of service by elected officers, even when their honesty of purpose is assured. One arises from uncertainty of the ability of these officers to determine correct standards of cost and efficiency. The other comes from lack of such experience as will enable them to apply standards justly in individual instances.

The time must come when it will be generally recognized that unbiased determination of facts as they are, and ruling thereon without prejudice or partisanship, is the only method of securing efficient service at justifiable rates.

Municipal ownership is neither the "bug-a-boo" nor the "cure-all" claimed for it by its enemies and friends respectively. It will not replace successfully the private corporation unless it retains the principles of good management and discards the elements of bad management which attach to the present system of distribution. It will surely replace the private corporation, as a matter of public necessity, unless there be found effective means of securing the same ends by public control.

Any man or woman who cares more to justify opinions than to reconcile opinions to the truth is a menace to society, whether the cause be venal motive or ignorance. Incorporation of utilities under public ownership is but an evolution of the private corporation, itself the evolution of individual proprietorship.

Finally, it is the engineer who will be in demand in the future, because his profession is the one which trains an unbiased attitude and the getting of results in accordance with the immutable laws of Nature, which after all determine the price of water, gas, electric current, telephone service and transportation of goods and of men.

But all these irritating questions, which afford free capital for loud-mouthed agitators, are to be settled by force of circumstances beyond any man's power to permanently brook, and the most of them are merely side issues to the main necessity of directing public control into wholesome, intelligent and competent channels of administration.

Engineers must think upon these matters, and to a purpose; and in much larger degree than some of you may be aware, the settlement is to come from the work of engineers who can see clearly, act promptly and meet and conquer in emergencies. The real engineer is the one who conquers emergency situations, and an emergency is confronting us now which demands courageous and dauntless energy to prevent dire disaster. As the true engineer will save life at any cost of property, in case of fire or flood, so must every consideration now be made to give way in our ranks, to the greater good of humanity. But coolness and calm judgment are as necessary as bravery, and there is no call for sacrifice of the substance in order to save the unknown shadow which may not prove to indicate the presence of a human, after all.

SIX METHODS OF COMPUTING IRREGULAR AREAS.[1]

BY ROBERT SIBLEY.

The engineer is often confronted with the problem of computing the areas of irregular figures. Of course, when a figure has definite symmetrical boundaries the computation of areas by the simple laws of elementary arithmetic and geometry follows at once. When, however, the boundary line of these areas is irregular in shape, at times it becomes a problem to estimate the enclosed area with a sufficient degree of accuracy, especially if no planimeter or mechanical area measuring machine is at hand. It is convenient, then, to have at hand definite methods with which to attack the problem of area computation when caught short-handed .

The following methods are compiled particularly for the computation of areas for indicator cards but as a matter of fact they are equally applicable to all other areas necessary to be computed. The six methods to be discussed in this lecture are as follows:

1. The small square method.
2. The trapezoidal rule.
3. The line proportional to area method.
4. By weighing.
5. Simpson's rule.
6. The planimeter.

Let us now proceed to study these six different methods and master them if possible, in order that we may be ready at all times to meet such problems as may arise in the computation of areas. By mastering these six methods we can pick from them when occasion arises the one which will apply with the greatest degree of accuracy upon the problem in which it is necessary for us to compute the area.

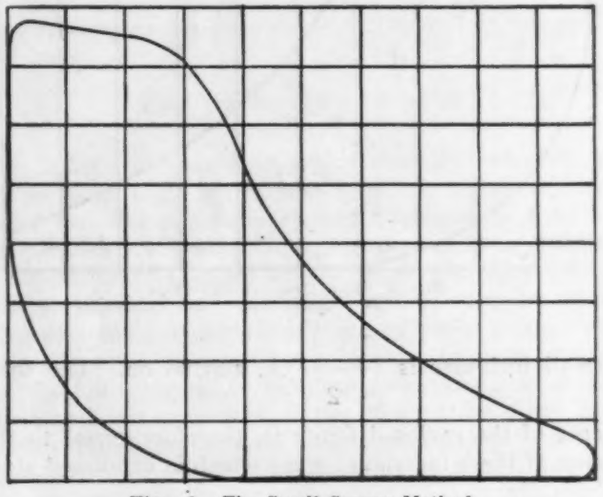


Fig. 1. The Small Square Method.

1. The small square method. By reference to Fig. 1 we see that the irregular shaped area is first platted to a definite scale and then the entire enclosure is divided into small squares. By simply counting these squares and approximating the small fractions of squares around the perimeter of the area and adding these to our number of whole squares, we

[1]This paper comprises the Eighteenth Lecture of the series appearing in these columns entitled "Primer of Applied Thermodynamics."

thus arrive at a value for the complete area enclosed. If now we multiply this area by the square of the scale to which our figure is drawn, we at once arrive at the area. It is evident that the smaller these squares are made the more nearly will we arrive at a true result. Hence squares should be taken as small as is convenient in the working out of a definite problem.

2. The trapezoidal rule. This method is used a great deal in the computation of railway road-beds and other earth excavation work. The given figure, which is seen by referring to Fig. 2, is divided by a series of equally distant parallel lines; such as a, b, c, d, etc. As shown in Fig. 2 the individual line is distant from its neighbor by h units. By looking at this figure we see that the small areas now making up the complete enclosure are very approximately trapezoids.

In elementary geometry we learn that the area of a trapezoid is equal to ½ the sum of the parallel sides multiplied by the perpendicular distance between them. Hence looking at Fig. 2 we see that the area of the first small enclosure on the left is $(\frac{a+b}{2})$ h, and the area of the second small enclosure $(\frac{b+c}{2})$ h, and likewise the area of the third

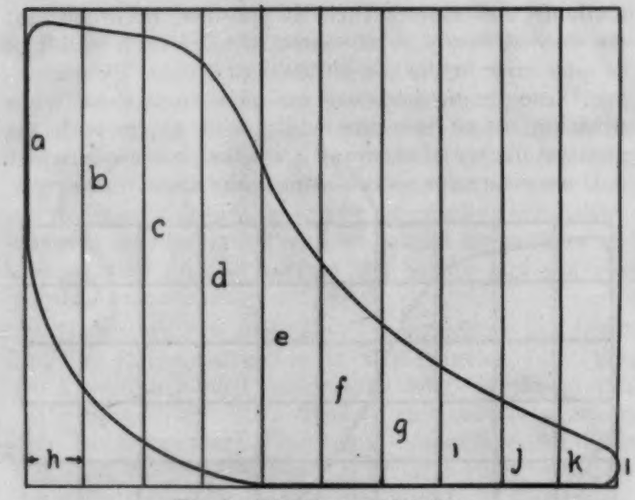


Fig. 2. The Trapezoidal Rule.

small inclosure is $(\frac{c+d}{2})$ h, and so on. The total area of the enclosed figure is, therefore, equal to the sum of these individual areas which is expressed algebraically

$$\text{Area} = (\frac{a+b}{2})h + (\frac{b+c}{2})h + (\frac{c+d}{2})h + \ldots + (\frac{k+l}{2})h$$

$$= h(\frac{a}{2} + b + c + d \ldots\ldots + k + \frac{l}{2})$$

In other words the area by the trapezoidal method is equal to the summation of one-half the first ordinate plus the sum of the intermediate ordinates plus one-half the last ordinate multiplied by the distance between any two. This is seen, then, to represent a remarkably easy yet accurate method of arriving at the area of an enclosure.

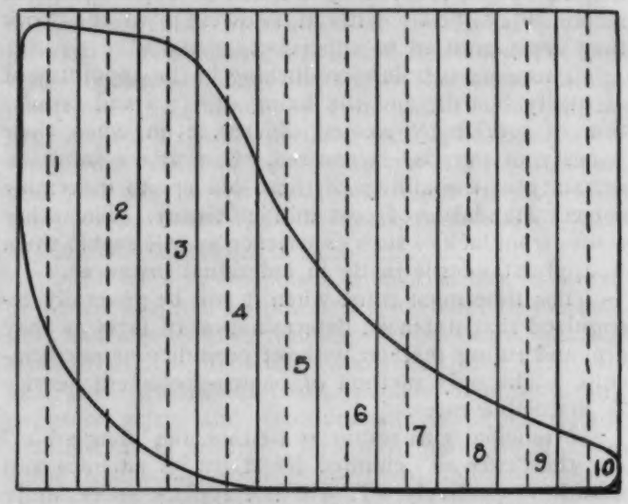


Fig. 3. The Line Proportional to Area Method.

3. The line proportional to area method. As signified by the name this method consists again in dividing the figure in small areas as shown in Fig. 3. By reference to this figure it is seen that by their average length 1, 2, 3, 4, etc., represent approximately by their length the area of each little small subdivision, hence if we scale off these lengths and sum them up either graphically or arithmetically we can at once arrive at an approximate measurement of the whole of the enclosure. This process while not as accurate as the trapezoidal method, is yet more convenient at times, especially in the case of certain graphic treatment of forces met with in the design of roof and bridge structures. In its use, however, by simply dividing the area of any figure, it is simple and easy of application.

4. By weighing. When one has ready access to a set of balances, this method is at once simple and accurate. It consists simply of plotting accurately to scale the enclosure which contains the area desired. It is necessary, however, in choosing and selecting the paper upon which this enclosure is platted to use careful judgment in the way of choosing an even, uniform paper.

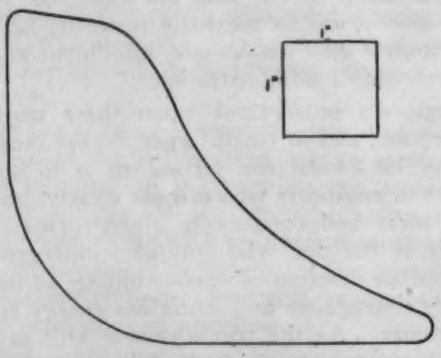


Fig. 4. Method of Weighing.

After the enclosure has been carefully and accurately plotted to the scale, the outline of the figure as

shown by illustration in Fig. 4 is cut out with a pair of scissors and weighed upon a pair of delicate balances. After this has been performed an area, 1 in. x 1 in. or in other words an areea of 1 sq. in. is also weighed upon the scales. It is seen now that the true area of the figure described is as many square inches in size as the weight of the one sq. in. section is contained in the weight of the complete area.

5. Simpson's Rule. In the consideration of the trapezoidal rule we find that the end lines connecting the non-parallel sides of the small areas were assumed to be straight, whereas in reality they are curved.

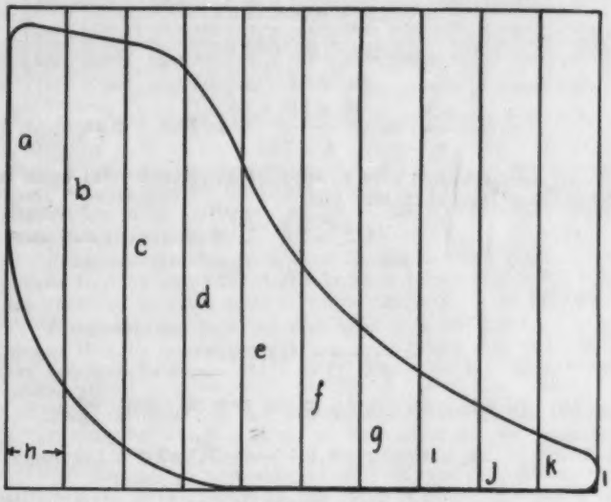


Fig. 5. Simpson's Rule.

Years ago, a mathematician and engineer by the name of Simpson, observed this fact and still further approximated the area of each small enclosure. This approximation is in fact so exact that it has been adopted universally by engineers in the computation of areas. In deducting the theoretic basis for his rule, Simpson made use of the well known theorem in analytic geometry that "the area of a segment of a parabola is equal to two-thirds the area of the circumscribing parallelogram." Looking now for an instant at Fig. 6, we can at once follow the simple reasoning by which this useful law was founded. In this figure BDGF, represents the segment of a parabola, the area BCDEGF represents the area of the circumscribing parallelogram in which the point D in the line CE is tangent to the parabola.

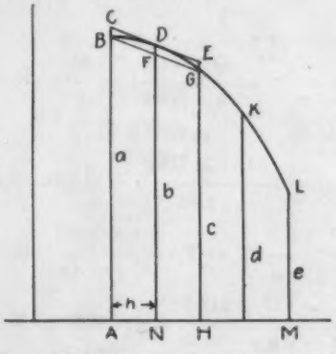


Fig. 6. Analytical Proof of Simpson's Rule.

If now we divide the parabolic arc BDGKL into an even number of small areas shown at a, b, c, d, e, some interesting results follow. Let us for a moment consider the area of the figure ABDGH.

$$\text{Area ABGH} = \left(\frac{a+c}{2}\right) 2h$$

$$\text{Area BDGF} = 2/3 \text{ Area BCDEG}$$

$$= 2/3\ (DF) \times 2h$$

$$\text{But } DF = DN - FN$$

$$\text{or } DF = b - \frac{a+c}{2}$$

$$\therefore \text{Area BDGF} = \frac{2}{3}\left(b - \frac{a+c}{2}\right) 2h$$

$$\text{Hence areas ABDGH} = \left(\frac{a+c}{2}\right) 2h + \frac{2}{3}\left(b - \frac{a+c}{2}\right) 2h.$$

In a similar manner the next two small areas can be grouped together and we have

$$\text{Area HGKLM} = \left(\frac{c+e}{2}\right) 2h + \frac{2}{3}\left(d - \frac{c+e}{2}\right) 2h$$

By adding this result to the former we get the total area shown in Fig. 6. Thus,

$$\text{Total area} = \left(\frac{a+c}{2}\right) 2h + \frac{2}{3}\left(b - \frac{a+c}{2}\right)$$

$$2h + \left(\frac{c+e}{2}\right) 2h + \frac{2}{3}\left(d - \frac{c+e}{2}\right) 2h$$

$$= h\left[a + c + \frac{4}{3}b - \frac{2}{3}a - \frac{2}{3}c + c + e + \frac{4}{3}d - \frac{2}{3}c - \frac{2}{3}e\right]$$

$$= h\left[\frac{a}{3} + \frac{4}{3}(b+d) + \frac{2}{3}c + \frac{e}{3}\right]$$

$$= \frac{h}{3}\left[(a+e) + 4(b+d) + 2c\right]$$

If now we let $(a+e) = A$, $(b+d) = B$, $c = C$, we have

$$\text{Total area} = \frac{h}{3}[A + 4B + 2C]$$

From this reasoning which is easily extended so as to cover any even number of small segments, it is seen that if any area is divided by means of a series of parallel equi-distant lines, forming an even number of small areas as were drawn in the consideration of the trapezoidal rule (although in that case the number of areas may be either even or odd), a complete law for area computation follows at once by means of the following rule. If A represents the sum of the first and last ordinates, C the sum of the other odd ordinates, B the sum of the even ordinates and h the perpendicular distance between each adjacent ordinate, then the

$$\text{Area} = \frac{h}{3}(A + 4B + 2C)$$

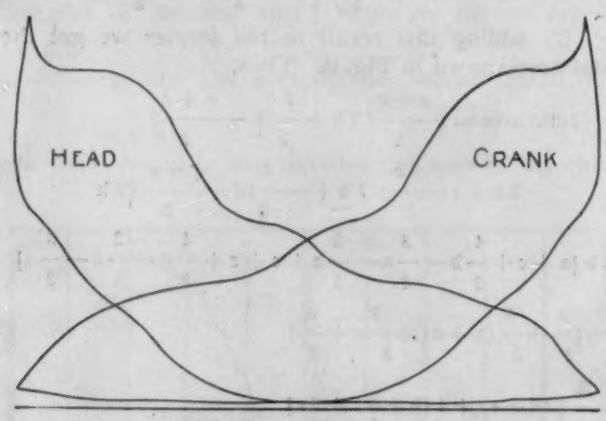
6. The planimeter. This method is at once the most exact and most popular method known to the modern science of engineering in the computation of irregular shaped areas. The planimeter appears to the trade in a variety of forms. The basis of the theoretic considerations upon which it operates involves the use

of that branch of higher mathematics known as calculus and hence the theory underlying it will not be undertaken at this time. Suffice it to say, however, that its principle depends upon sound reasoning.

In order to measure an area by means of a planimeter it is simply necessary to run a marker accurately around the perimeter of the enclosure whose area it is desired to obtain. It is of course necessary to observe certain other rules, depending upon the particular style of planimeter made use of by the engineer. As this instrument is however expensive and better adapted for office use than for the field, it is restricted in its wide-spread application largely to the draughting room. Hence a thorough mastery of the first five methods of computing areas as detailed in this lecture is very essential for the field engineer.

Thermotwisters.

1. Given the indicator cards of crank and head ends as shown below taken from a steam engine, compute the area by all six methods, thus satisfying yourself as to accuracy of each.



Problem in Area Measurement.

SOLUTION OF THERMOTWISTERS—TWELFTH LECTURE

1. If 500 B.t.u. are added to 6 lb. of air having a pressure of 30 lb. per sq. in. and a volume of 30 cu. ft. what is the final v, p, t and the work done?

(a) When the heat is supplied and expansion takes place at constant pressure.

(b) When the heat is supplied and expansion takes place at constant temperature.

(c) When the heat is supplied and the volume remains constant.

(d) When the heat is supplied and the expansion follows the law $p v^{0.6} = K$.

(a) $p_1 = 30 \times 144$ $v_1 = \frac{35}{6}$ $p_1 v_1 = R T_1$ $Q = \frac{500}{6}$ or heat supplied per lb.

$$T_1 = \frac{p_1 v_1}{R} = \frac{30 \times 144 \times 35}{53.37 \times 6} = 472.°0$$

$$Q = C_p (T_2 - T_1) \text{ where } Q = \frac{500}{6},\ C_p = .239\ \ T_1 = 472.0$$

$$\frac{500}{6} = .239\ (T_2 - 472.5) \text{ or } T_2 = \frac{500}{6 \times .239} + 472.0 = 821.0$$

$$p_2 v_2 = R T_2,\quad v_2 = \frac{R T_2}{p_2} = \frac{52.37 \times 821.0}{30 \times 144} = 10.13$$

$$\text{Work} = 6 \times \frac{R}{1-n} (T_2 - T_1) = 6 \times \frac{53.37}{1-0} (821 - 472)$$

$$= 18{,}620 \times 6 = 111{,}720 \text{ ft. lb. Ans.}$$

(b) Since law of expansion is in this case $p v = K$.

$$Q = p_1 v_1 \log_e \frac{v_2}{v_1}$$

$$778 \times \frac{500}{6} = 30 \times 144 \times \frac{35}{6} [\log_e v_2 - \log_e \frac{35}{6}]$$

$$= 30 \times 144 \times \frac{35}{6} \times 2.306\ [\log_{10} v_2 - \log_{10} \frac{35}{6}]$$

$$\log_{10} v_2 = \frac{778 \times 500 \times 6}{6 \times 30 \times 144 \times 35 \times 2.306} + \log_{10} \frac{35}{6}$$

$$= 0.1116 + 0.7661 = 0.8777$$

$$\therefore v_2 = 7.55$$

$$p_2 v_2 = p_1 v_1$$

$$\therefore p_2 = \frac{p_1 v_1}{v_2} = \frac{30 \times 144 \times 35}{6 \times 7.55} = 3336. \quad \text{Ans.}$$

All heat supplied goes toward work. Hence total work is $500 \times 778 = 389{,}000$ ft. lb. Ans.

(c) $$Q = C_v (T_2 - T_1)$$

$$\frac{500}{6} = .17\ (T_2 - 472.)$$

$$\therefore T_2 = \frac{500}{6 \times .17} + 472 = 962.5$$

(d) In this case $n = 0.6$ in the general equations.

$$Q = C_v (T_2 - T_1) + \frac{R}{1-n} (T_2 - T_1)$$

$$\frac{500}{6} = .17\ (T_2 - 472) + \frac{53.37}{1-0.6} (T_2 - 472) \times \frac{1}{778}$$

$$\frac{500}{6} = (T_2 - 472.5)\ [.17 + \frac{53.37}{0.4 \times 778}] = (T_2 - 472.5)\ (.3415)$$

$$T_2 = \frac{500}{6 \times .3415} + 472.5 = 716°.5. \quad \text{Ans.}$$

$$p v^{0.6} = K \text{ or } R T_2 v_2^{0.6} = R T_1 v_1^{0.6}$$

Substituting

$$v_2^{0.6} = \frac{T_1}{T_2} v_1^{0.6}$$

$$\therefore v_2 = v_1 (\frac{T_1}{T_2})^{\frac{1}{0.6}} = \frac{35}{6} (\frac{472.5}{716.5})^{\frac{1}{0.6}} = \frac{35}{6} \times .50 = 2.92. \quad \text{Ans.}$$

$$p_2 v_2 = R T_2$$

$$\therefore p_2 = \frac{53.37 \times 716.5}{2.92} = 13{,}100. \quad \text{Ans.}$$

$$\text{Work} = \frac{6 R}{1-n} (T_2 - T_1) = \frac{6 \times 53.37}{1-0.6} (716 - 472.5)$$

$$= \frac{6 \times 53.37 \times 243.5}{0.4} = 194{,}800 \text{ ft. lb. Ans.}$$

2. The above air expands adiabatically until the final volume is 70 cu. ft. what is the final p, t, and the work done?

$$p_2 v_2^{1.41} = p_1 v_1^{1.41}$$

$$p_2 = p_1 (\frac{v_1}{v_2})^{1.41} = 30 \times 144 (\frac{35}{70})^{1.41}$$

$$\therefore p_2 = 30 \times 144 \times .371 = 1601. \quad \text{Ans.}$$

$$p_2 v_2 = R T_2$$

$$\therefore T_2 = \frac{p_2 v_2}{R} = \frac{1601 \times 70}{53.37} = 2101°. \quad \text{Ans.}$$

SOLUTION OF THERMOTWISTERS—THIRTEENTH LECTURE.

1. Take Fig. 32 which gives a page from Peabody's Steam and Entropy Tables and connect up all computations for each column as was done in this lecture for Fig. 33.

40 SATURATED STEAM—TABLE I.

Temperature, Degrees Fahrenheit. t	Pressure, Pounds per Square Inch. p	Heat of the Liquid. q	Heat of Vaporization. r	Heat Equivalent of Internal Work. p	Heat Equivalent of External Work. Apu	Entropy of the Liquid. θ	Entropy of Vaporization. $\frac{r}{T}$	Specific Volume, Cubic Feet per Pound. v	Density, Pounds per Cubic Foot. $\frac{1}{v}=s$	Temperature, Degrees Fahrenheit. t
228	20.02_{38}	196.5	959.4	885.1	74.3	0.3363	1.3955	20.07_{35}	0.04983_{87}	228
229	20.40_{38}	197.5	958.7	884.3	74.4	0.3378	1.3925	19.72_{35}	0.0507_{9}	229
230	20.78_{39}	198.5	958.1	883.6	74.5	0.3392	1.3895	19.37_{33}	0.0516_{9}	230
231	21.17_{40}	199.5	957.4	882.8	74.6	0.3407	1.3866	19.04_{33}	0.0525_{9}	231
232	21.57_{40}	200.5	956.8	882.1	74.7	0.3422	1.3836	18.71_{32}	0.0534_{10}	232
233	21.97_{41}	201.5	956.1	881.3	74.8	0.3436	1.3806	18.39_{31}	0.0544_{9}	233
234	22.38	202.5	955.4	880.6	74.8	0.3451	1.3777	18.08.	0.0553	234

Fig. 32. Page from Peabody's Steam and Entropy Tables.

Let us take line corresponding to 231° F. in column one. From column two we read that at 231° F. saturated steam has a pressure of 21.17 lb. per sq. inch abs. This would correspond to 6.47 lb. gauge.

From column three we read that q is 199.5 B.t.u., which means that by experiment it has been found that 199.5 B.t.u. are required to raise 1 lb. of water from 32° F. to 231° F.

From column four we find that r is 957.4 B.t.u., which means that by experiment it has been found that 957.4 B.t.u. are required to evaporate 1 lb. of water at 231° F. into saturated steam at 231° F.

From column five we are informed that P has a value of 882.8 B.t.u., which informs us that although we have just found 957.4 B.t.u. required to evaporate 1 lb. of water at 231° F. into saturated steam at 231° F., yet only 882.8 B.t.u. still remain in the steam in the form of internal energy, and as a consequence in considerations of the steam turbine expansion use of steam, this would be the value to use.

Column six states that of the heat required to evaporate a pound of water at 231° F. into saturated steam at 231° F. 74.6 B.t.u. are necessary to overcome external work as the water expands into saturated steam. We have found that work performed in expansion under constant pressure is computed by the product of the pressure and volume. This result is in ft. lb. and to convert into B.t.u. we must divide by 778. Or since the pressure is 21.17×144 lb. per sq. ft. and the volume 19.04 cu. ft. per lb. we have

$$\text{External work} = \frac{21.17 \times 144 \times 19.04}{778} = 74.6 \text{ B.t.u.}$$

Column seven, headed entropy of liquid, follows at once from its definition.

$$\theta = \log_e \frac{T_2}{T_1} = 2.306 \log_{10} \left(\frac{231 + 459.4}{32 + 459.4}\right)$$

$$= 2.306 \log_{10} \left(\frac{690.4}{491.4}\right) = 0.3407. \quad \text{Ans.}$$

Entropy of vaporization, heading column eight, is $\frac{r}{T}$ and is equal to

$$\frac{957.4}{459.4 + 231} = \frac{957.4}{690.4} = 1.3866. \quad \text{Ans.}$$

The ninth column or specific volume is computed from the formula

$$L = T \left(\frac{\Delta p}{\Delta t}\right) (v - v_1)$$

$L = r = 957.4$, $T = 231 + 459.4 = 690.4$, Δp is the increase in pressure in lb. per sq. ft. from 230° to 232° or the increase for $\Delta t = 2$ and is seen to be $21.17 \times 144 - 20.78 \times 144 = .79 \times 144$, v is the quantity s which we desire and v_1 is the volume occupied by 1 lb. of water, which is .016 cu. ft.

$$778 \times 957.4 = 690.4 \left(\frac{.79 \times 144}{2}\right) (s - .016)$$

$$s = \frac{957.4 \times 2 \times 778}{690.4 \times .79 \times 144} + .016 = 19.04. \quad \text{Ans.}$$

The tenth column is simply the reciprocal of the ninth column or $\frac{1}{s} = \frac{1}{19.04} = 0.0525$. Ans.

LIST OF FRANCHISES ABOUT TO EXPIRE IN SAN FRANCISCO.

The following street railway franchises are about to expire in San Francisco. As the success of the great Panama Pacific International Exposition of 1915 largely depends upon the facility of transportation, the disposition of the expired franchises will be watched with much interest not only by engineers but the public at large:

TABULATION OF EXPIRING FRANCHISES

Street	From	To	Grantee.	Date of Commencement of Franchise.	Term of Franchise, yrs.	Order No.
Baker	Greenwich	Jefferson	Presidio & Ferry R'y Co.	Dec. 10, 1888	25	1549 2015
	Union	Greenwich	Presidio & Ferry R'y Co.	Dec. 10, 1888	25	2419
	Jefferson	Lewis	Presidio & Ferry R'y Co.	Dec. 10, 1888	25	2621
California	First Avenue	City Cemetery	G. Sutro	Dec. 1, 1886	25	1883
Clay	East	Battery	W. H. Martin et al.	July 14, 1886	25	1871
	Battery	Stockton	W. H. Martin et al.	Sept. 27, 1887	25	1926
East	Sacramento	Clay	W. H. Martin et al.	July 14, 1886	25	1871
	Washington	Market		Dec. 10, 1888	25	1549
	Washington	Jackson	Presidio & Ferry R'y Co.	Dec. 10, 1888	25	2015
Franklin	Vallejo	Union	Presidio & Ferry R'y Co.	Dec. 10, 1888	25	547ns
Greenwich	Baker	Lyon	Presidio & Ferry R'y Co.	Dec. 23, 1888	25	2419
Jackson	First Avenue	Steiner	W. H. Martin et al.	July 14, 1886	25	1871
	East	Montgomery	Presidio & Ferry R'y Co.	Dec. 10, 1888	25	2015 1549
Jefferson	Baker	Presidio Res.	Presidio & Ferry R'y Co.	Dec. 3, 1888	25	2015
Larkin	Union	Vallejo	Presidio & Ferry R'y Co.	Dec. 10, 1888	25	547ns
Mason	Washington	Montgomery	W. H. Martin et al.	July 14, 1886	25	1881
	Union	Jackson	Presidio & Ferry R'y Co.	Dec. 10, 1888	25	1549
Montgomery	Jackson	Washington	Presidio & Ferry R'y Co.	Dec. 10, 1888	25	2015
Presidio (Cen'l Av.)	Jackson	California	W. H. Martin et al.	Sept. 27, 1887	25	1926
Sacramento	Battery	East	W. H. Martin et al.	July 14, 1886	25	1871
	Battery	Powell	W. H. Martin et al.	Sept. 27, 1887	25	1926
Seventh Ave.	California	Golden Gate Park	W. H. Martin et al.	Sept. 27, 1887	25	1926
Steiner	Jackson	Washington	W. H. Martin et al.	July 14, 1886	25	1871
Stockton	Clay	Washington	W. H. Martin et al.	Sept. 27, 1887	25	1926
32d Avenue	California	Lake	G. Sutro	Dec. 1, 1886	25	1883 1549
Union	Montgomery Ave.	Steiner	Presidio & Ferry R'y Co.	Dec. 10, 1888	25	2015
	Steiner	Baker	Presidio & Ferry R'y Co.	Dec. 10, 1888	25	2015
Vallejo	Larkin	Franklin	Presidio & Ferry R'y Co.	Dec. 10, 1888	25	547ns
Washington	Steiner	Battery	W. H. Martin et al.	July 14, 1886	25	1871 1549
	Sansome	East	Presidio & Ferry R'y Co.	Dec. 10, 1888	25	2015

PRECIPITATION, ALTITUDE, AND GRADIENT IN THE SIERRA NEVADAS.

BY WILHELM KREBS, GROSSFLOTTBEK (HOLSTEIN).

The article of Mr. Charles. H Lee[1] on the exemplary studies made by the Los Angeles Aqueduct officials, on Precipitation and Altitude in the Sierras, was extraordinarily interesting to me due to one of its conclusions: "The general slope of the country seems to have more to do with the amount of precipitation than does altitude."

In the "Versammlung Deutscher Naturforcsher und Aerzte"[2] 1904, at Breslau, I expressed a similar conclusion: "The formation of precipitation depends more on the gradient of a slope than on the difference of altitude." This conclusion is more radical than that of Mr. Lee, but it is verified by observations made under suitable conditions in different parts of the world. Most convincing of these observations are those granting control by valuation. I beg permission for a short communication of such observations published by me in the "Deutsche Rundschanfur Geographie und Statistik" of August, 1890[3] and of September 1908[4]. (Wien, A. Hartlebens Verlag.)

Table 1. Slope of the Storm and Draken Mountains in South Africa directed ahead to the prevailing atmospheric drift in the Rains.

Name of Station.	I Distance from Coast.	II Elevation above sea level.	III Gradient from Coast II:I	IV. Amt. of mean seasonal precipitation.
1. King Williams Town	45 km.	400 m.	0.0089	639 mm.
2. Cathcart	110 km.	1200 m.	0.0109	769 mm.
3. Queenstown	160 km.	1070 m.	0.0067	507 mm.
4. Meritzburg	64 km.	640 m.	0.0100	743 mm.

Ratio of	Elevations. II.	Precipitations. IV.	Gradients of slope. III.
1. K. W. T. :2 Cathcart	1:3.0	1.:1.2	1:1.2
3. Qu. :2 Cathcart	1.5:1.0	1:1.5	1:1.5
1. K. W. T. :4 Mar.	1:1.6	1:1.3	1:1.1
3. Qu. :1 K. W. T.	3.6:1.0	1:1.3	1:1.3
4. Mar. :2 Cathcart	1:1.7	1:1.09	1:1.03

Ratio of	Elevations. II.	Precipitations. III.	Gradients of Slope. IV.
3. Qu. :4 Mar.	2.5 : 1.0	1 : 1.5	1 : 1.5

Table II. Eastern Slope of the Cordillera Santo Thomas, Cuzon.

Name of Station.	1. Distance from Coast.	II. Elevation above sea level.	III. Gradient from Coast.	IV. Amount of mean seasonal precipitation.
Bayombong	98 km.	253 m.	0.0026	1183
Baguio	140 km.	1456 m.	0.0104	4293

Ratio of	II. Elevations.	III. Precipitations.	IV. Gradients of slope.
Bay : Bag.	1 : 5.8	1 : 3.6	1 : 4.0

It is evident from Tables I and II that the ratio of precipitations in these cases agrees in a very high degree with the gradients of slope and differs in a high degree from the ratio of elevations.

Cases of such nature occur also on the sea-side slopes of the Sierra Nevada. I have chosen the best situated three stations of the Central Pacific group and of the Mokelumne Group and calculated in the same manner. Indeed the best site for such studies is the most exposed to that side in a middle level. As starting line of the gradient, were chosen not the sea-coast but the swampy banks of the Sacramento River, represented by Sacramento, and of the San Joaquin River, represented by Stockton.

Table III. Central Pacific Group of Stations on the sea-side of the Sierra.

Name of Station.	I. Distance from Sacramento.	II. Elevation above Sacramento.	III Gradient from	IV. Amt. of mean seasonal precipitation.
1. Auburn	48,870 km.	393 m.	0.0080	34.93 inches
2. Gold Run	78,519 km.	961 m.	0.0122	54.49 inches
3. Blue Canyon	94,125 km.	1410 m.	0.0150	72.82 inches

Ratio of	Elevations. II.	Precipitations. III	Gradients of slope. IV.
1. Auburn : 2. Gold Run	1 : 2.4	1 : 1.6	1 : 1.5
1. Auburn : 3. Blue Canyon	1 : 3.6	1 : 2.1	1 : 1.9
2. G. Run : 3. Blue Canyon	1 : 1.5	1 : 1.3	1 : 1.2

Table IV. Mokelumne Group of Stations on the sea-side of the Sierra.

Name of Station.	I. Distance from Stockton.	II. Elevation above Stockton.	III. Gradient from II : 1	IV. Amount of meani seasonal precipitation
1. Mokelumne Hill	65,969 km.	460 m.	0.0070	32.58 ins.
2. West Point	84,955 km.	847 m.	0.0100	42.50 ins.
3. Bear Valley Res.	116,653 km.	1762 m.	0.0151	63.35 ins.

Ratio of	II. Elevations.	III. Precipitations.	Gradients IV. of slope.
1. Mok. H. : 2. West P.	1 : 1.8	1 : 1.3	1 : 1.4
1. Mok. H. : 3. Bear V. R.	1 : 3.8	1 : 2.0	1 : 2.2
2. West P. : 3. Bear V. R.	1 : 2.0	1 : 1.5	1 : 1.5

The law above set forth is very evident from the Sierra stations of Tables III and IV. Application of the reduced precipitations causes only few slight variations of the law. Here I do not emphasize the scientific importance of such results but I insist upon their practical value. For instance I desire to hint at two possibilities revealed by the law: 1st. To find out the critical zone of precipitations on a mountain only by means of a simple profilation of its topographic map. 2d. To find out independent values of precipitation on the crest of the Sierra by applying this law to the Taboose Group, the Oak Group and the Bears Group of Precipitation Gages.

1. Journal of Electricity, Power and Gas, July 8, 1911, page 23.

2. Verhandlungen der Gesellschaft Deutscher Naturforcher und Aerzte 76. Versammlung fer Breslau, 18.-24. September, 1904. Leipzig, F. C. W. Vogel's Verlag, 1905, II. 1 p. 215. The concluded law is employed by me on page 223 of the same publication to explain the doubling of precipitation on the outskirts of a tall timber forest, observed by Professor F. Schubert of the Forest-Academy, Eberswalde.

3. W. Krebs: Uberdas Klima des aussertropischen Sudaprika L. c. p. 495.

4. W. Krebs: Die Niederschlagsverhaltuisse der Phillippinen. l. c. p. 535.

RADIOTELEGRAPHY IN URAGUAY.

Having permanently closed the private wireless-telegraph stations at Punta del Este and El Cerro, the Uruguayan Government has established one at Cerrito, the radius of which covers the whole territory of the Republic and extends for an equal distance over the ocean. The service opened for business on December 15, 1911.

There are 19 other stations in various parts of the Republic, those at Paso del Toros, Rivera, Flores Island, and the English Bank Lighthouse being stationary, the others being installed on the Government war vessels, and 9 portable ones.

The station at Cerrito is connected with the central post office by an underground cable, over which all wireless messages are received and then delivered to the persons addressed.

It is estimated that the annual expense of the system will be $24,000, the receipts being about the same. The tariff is 10 cents per word, with a minimum of 20 words.

NOTES ON REVISED COEFFICIENTS OF FRICTION FOR PIPES.

BY JOS. N. LE CONTE.

Williams & Hazen have published in their excellent little treatise a number of coefficients found in the flow of water through pipes. Their law is

$$v = c\, r^{0.63}\, s^{0.54}\, 0.001^{-0.04} \quad \ldots\ldots (1)$$

in which v is the velocity of the water in feet per sec., c is a constant, s is the slope or drop in the hydraulic gradient per foot.

As these new constants have been accurately determined by experiment it is interesting and instructive to deduce from them revised values of λ in order to apply the equations ordinarily used in pipe computation.

Now by the old familiar formula

$$s = \lambda \frac{1}{d} \frac{v^2}{2g} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

In formula (1) let us substitute a value of 100 for c and a value of $r = \frac{d}{4}$ for the hydraulic radius of a pipe. This will give us the equation

$$v = 100 \left(\frac{d}{4}\right)^{0.63} s^{0.54}\, 0.001^{-0.04} \quad \ldots\ldots\ldots (3)$$

and if we now substitute for 1 in equation (2) a length of one foot we have

$$s = \lambda \frac{v^2}{64.4d} = 0.01553 \frac{v^2}{d} \lambda \quad \ldots\ldots\ldots\ldots\ldots (4)$$

Equating values in equations (3) and (4) thereby eliminating s, we have

$$.0006 \frac{v^{1.85}}{d^{1.166}} = \lambda\ .01553 \frac{v^2}{d}$$

$$\lambda = .0387 \frac{1}{v^{0.15}\ d^{0.166}}$$

The following values of λ have been computed by substituting in this last formula data obtained from the new and revised experiments of Williams & Hazen:

				VALUES OF λ		
	(1.048)	(1.380)	(1.611)			
Diam in.	1"	1¼"	1½"	2"	2½"	3"
Area Sq. ft.	.00598	.01038	.01315	.02182	.04909	.04909
Vel. ft. sec.			VALUES OF λ			
.1	.0830	.0790	.0770	.0741	.0711	.0690
.3	.0700	.0669	.0650	.0628	.0602	.0586
.5	.0649	.0620	.0602	.0581	.0558	.0541
.75	.0611	.0582	.0568	.0548	.0525	.0510
1.0	.0584	.0558	.0542	.0524	.0502	.0489
1.5	.0550	.0525	.0511	.0494	.0474	.0460
2.0	.0527	.0502	.0490	.0472	.0454	.0441
2.5	.0510	.0487	.0474	.0458	.0439	.0427
3.0	.0496	.0473	.0461	.0445	.0428	.0415
3.5	.0484	.0462	.0450	.0435	.0418	.0405
4.0	.0475	.0452	.0441	.0426	.0409	.0397
5.0	.0460	.0438	.0427	.0412	.0395	.0385
6.0	.0447	.0427	.0416	.0400	.0385	.0374
7.0	.0437	.0417	.0405	.0392	.0376	.0365
8.0	.0429	.0409	.0598	.0384	.0369	.0359
10.0	.0414	.0395	.0385	.0371	.0357	.0347
12.0				.0360	.0347	.0337
16.0				.0344	.0331	.0322

Diam. in	4"	6"	8"	10"	12"	14"
Area Sq. ft.	.08726	.1963	.3491	.5454	.7854	.11069
Vel. ft. sec			VALUE OF λ			
.1	.0662	.0620	.0610	.0579	.0549	.0538
.1	.0560	.0525	.0514	.0489	.0465	.0455
.5	.0520	.0484	.0461	.0445	.0430	.0420
.75	.0488	.0455	.0433	.0418	.0403	.0395
1.0	.0466	.0435	.0415	.0401	.0387	.0379
1.5	.0440	.0410	.0390	.0377	.0365	.0357
2.0	.0410	.0392	.0374	.0361	.0349	.0341
2.5	.0403	.0379	.0362	.0350	.0337	.0330
3.0	.0396	.0369	.0351	.0340	.0328	.0321
3.5	.0387	.0360	.0343	.0332	.0320	.0313
4.0	.0379	.0353	.0337	.0326	.0315	.0308
5.0	.0367	.0342	.0325	.0315	.0304	.0297
6.0	.0357	.0332	.0317	.0307	.0296	.0290
7.0	.0349	.0325	.0310	.0300	.0289	.0283
8.0	.0342	.0318	.0303	.0294	.0284	.0278
10.0	.0331	.0309	.0294	.0284	.0274	.0268
12.0	.0321	.0296	.0285	.0276	.0266	.0260
16.0	.0307	.0283	.0273	.0264	.0255	.0249
20.0	.0296	.0273	.0264	.0355	.0246	.0241

Diam. in.	16"	18"	20"	24"	30"
Area Sq. ft.	1.396	1.767	2.182	3.142	4.909
Vel. ft. sec			VALUE OF λ		
.1	.0526	.0515	.0507	.0491	.0473
3.	.0446	.0436	.0429	.0416	.0400
5.	.0411	.0401	.0395	.0384	.0469
.75	.0386	.0378	.0372	.0361	.0347
1.0	.0370	.0362	.0356	.0345	.0352
1.5	.0348	.0340	.0335	.0325	.0312
2.0	.0334	.0326	.0321	.0311	.0299
2.5	.0322	.0315	.0310	.0300	.0289
3.0	.0314	.0307	.0302	.0292	.0281
3.5	.0306	.0299	.0295	.0286	.0275
4.0	.0301	.0294	.0290	.0280	.0269
5.	.0411	.0401	.0395	.0384	.0460
6.0	.0283	.0277	.0273	.0263	.0253
7.0	.0276	.0270	.0266	.0258	.0248
8.0	.0271	.0265	.0261	.0252	.0243
10.0	.0262	.0256	.0252	.0244	.0235
12.0	.0254	.0248	.0244	.0237	.0228
16.0	.0244	.0238	.0234	.0227	.0218
20.0	.0235	.0230	.0226	.0219	.0211

Diam in.	36"	42"	48"	54"	60"
Area Sq. ft.	7.068	9.621	12.566	15.904	19.635
Vel. ft. sec.			VALUE OF λ		
.1	.0459	.0447	.0439	.0430	.0422
.3	.0388	.0378	.0371	.0369	.0357
.5	.0358	.0349	.0342	.0335	.0329
.75	.0336	.0367	.0321	.0315	.0309
1.0	.0322	.0314	.0307	.0301	.0291
1.5	.0303	.0295	.0289	.0284	.0278
2.0	.0290	.0282	.0277	.0272	.0267
2.5	.0281	.0273	.0267	.0262	.0258
3.0	.0273	.0265	.0260	.0255	.0251
3.5	.0267	.0259	.0254	.0250	.0245
4.0	.0262	.0254	.0249	.0244	.0240
5.0	.0253	.0246	.0241	.0237	.0232
6.0	.0247	.0239	.0234	.0230	.0227
7.0	.0241	.0234	.0229	.0225	.0221
8.0	.0236	.0229	.0224	.0220	.0217
10.0	.0228	.0221	.0217	.0213	.0210
12.0	.0221	.0215	.0211	.0207	.0203
16.0	.0212	.0205	.0201	.0198	.0195
20.0	.0204	.0198	.0194	.0191	.0188

JAPANESE HYDROELECTRIC PLANTS.

Recent Consular reports state that American machinery is in demand in connection with the development of hydroelectric power plants of Japan.

MAMMOTH ELECTRICAL SHOW.

The largest electrical show in the world will be held in Boston in September. The Mechanics building, which will contain it, seats over 100,000 people at one time, and has 105,000 square feet of exhibit space.

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Precipitation Altitude and Gradient

Some months ago there appeared in the columns of the Journal an article by Chas. H. Lee on the relation of precipitation and altitude in the high Sierras. The data used in deducing the conclusions set forth were those compiled by the exhaustive experiments of the hydrographic department of the Los Angeles aqueduct. The general conclusion drawn by Mr. Lee is that the slope of the country seems to have more to do with the amount of precipitation than does the altitude. The article seems to have met with much interested discussion throughout the technical press of the world.

Elsewhere in these columns is to be found a contribution from Wilhelm Krebs, the well-known German expert who has made similar investigations upon other continents than those of America. Mr. Krebs first gives us some interesting deductions from a series of experiments made along the north coast of Africa near the ancient site of the city of Carthage. By comparing the different stations one with the other it is seen at a glance that no uniform law of varying amounts of precipitation with altitudes is possible, but a law based on the gradient—the ratio of the altitude to the distance from the sea-coast or swampy bottom lands—gives at once a uniform and consistant increase of precipitation.

As stated by Mr. Krebs the scientific importance of this law is overshadowed by its practical value. When desiring data on precipitation in an unexplored field, for instance, the precipitation can be quickly determined by comparing the gradient of the new station with that of a neighboring station where complete data are available.

Another feature is of interest, namely that the distance from the sea-coast does not always seem to be the proper beginning point for gradient computation. In the case of the Sierra Nevada Mountains for example, the bottom lands of the great interior basin of California through which drain the San Joaquin and Sacramento rivers, seem to be the proper zero line.

San Francisco Franchises

Elsewhere in these columns will be found details covering some thirty street railway franchises which are about to expire in the city of San Francisco. Speculation is rife among the citizens of that municipality as to the proper attitude to take. The Geary Street railroad in its present situation certainly presents some features which make the serious minded stop to think. It seems most unfortunate that a railroad possessed of every gift of nature such as the Geary Street project should be so hampered by political forces as has been the case during past years.

In the good old days when this railroad was under private ownership it was one of the best money makers in the West and even after the expiration of the franchise the percentage of gross earnings demanded by the city of San Francisco made a handsome return each month for the privilege granted. The slow drifting progress made by the recent city management is a disgrace to the municipality. It is to be hoped that under the cross-fire of the Finance Com-

mittee put forth by the life-saving Rolph administration will at once exert the big stick at the psychological moment, which is now.

It is not the purpose of these columns to favor either private or municipal ownership but suffice it to say that a good energetic private corporation would have had the dividend paying cars racing up and down Geary Street months ago. With an international exposition but three years ahead it behooves every transportation company leading to the Golden Gate metropolis to explode a keg of dynamite and wake up.

The vandalism displayed by the last city government in the changing of cornerstones set by the previous administration, the stringing of trolley wires from house to house, then tearing the same down are but eye-openers to the inefficiency and energy-dissipating make-up of the past. The recent enormous deficits brought to light by the investigations of the Finance Company involving over a million dollars certainly show a startling situation in the activities of the Public Works Commission.

Parasites, leaching out the very life blood of the city's financial resources, should be shown the strong arm of the decent element of the city. With every prospect ahead for the greatest era of any city in the history of the world, San Francisco has at once an opportunity to set an example for good government which should not be overlooked. Not the least among these opportunities is that of displaying to the world the most efficient transportation system possible to design by the genius of man.

The city of San Francisco is fortunate in having been able to procure the services of the celebrated traffic expert, Bion J. Arnold. Mr. Arnold is not to be envied in the surgical operation he has ahead. Let us hope, however, that when the surgical operation is completed it will be pronounced a success, not because the patient died under the knife as was recently jocularly exemplified at the Pajama Rally at the California State University, but rather in the sense that all dead portions of the suffering patient be removed and the live healthy portions given every encouragement for future healthy growth.

The Golden Gate City is not the only one interested in the upbuilding of an efficient tranportation system for the safe carrying of her people. Nor would we include all interested if the limits were extended to the outward boundaries of the State of California. The entire West looks toward the risen city with eyes of expectancy. A quick and positive solution of the transportation problems for the city of 1915 will add much toward molding those words of national approval which every true Westerner expects to hear in 1916: "San Francisco made good."

Force

We called attention editorially in the last issue of the Journal to the lack of a certain quality in engineering specifications, and that lacking quality we found to be clearness. It is indeed true that of all the characteristics necessary in the presentation of either an engineering project or of a one-meaning specification, clearness, above all else should be the ruling feature. It is to be regretted, however, that so much of our technical literature smacks of its mechanical construction, smells of the oil necessary in its proper lubrication. As a profession, we lack in expression to set forth, what we, as engineers, inwardly feel.

As the engineer looks into the mountain stream he is overcome, often, with the beauty of its clearness and yet its clearness alone would be of but passing interest to our profession; its force is the inner something which touches us to the depths within. And so it is easily seen that while in the writing of specifications and in the drawing up of contracts the ruling characteristic of expression should be clearness, yet when the engineer desires to move men to action his expression in addition to clearness should carry with it the all powerful elements of force.

Let us then in a few words see how this lacking quality may be acquired. In our lighter moments we have learned that "Force is that which lifts Sunny Jim over the fence," and even in times of serious reflection when considering the proper make-up of the engineer's report we find that force is that quality of expression which lifts us above the ordinary humdrum of life into a plane where is to be seen the constructive imagination of the engineer himself. To obtain force in written expression the engineer should bear in mind a unified purpose throughout his report. Each word, each sentence, each paragraph should be so arranged that the eye will readily catch the most important points, and above all there should be in considering throughout the report each element with its neighbors, a clearly defined coherence.

The paragraph may well be said to possess unity if its entire subject matter can be readily expressed in a single sentence. A sentence may be worded in such a way that the important points readily strike the eye by putting at the end the most important word in the sentence. Similarly the last sentence of the paragraph commands attention for the most important points of discussion. Again, force is added by putting the next to the most important parts first in the sentence or paragraph. Coherence is readily obtained in a sentence by grouping together words of like meaning and separating as far as possible words of unlike meaning. Similarly in grouping the sentences of paragraphs by grouping those of like meaning together and separating as far as possible those of unlike meaning coherence is obtained. A careful choice of connectives when these methods fail will aid materially in adding to the expression an unlooked for force.

It is indeed true that great care must be used in exercising such rules as outlined above, for unless delicately applied the sentences may take on the appearance of even more mechanical besmirching than formerly. In conclusion let us remember that, above all, the use of figures picturing ideas not expressed in words greatly add to the force of the writing. Such a trait seems almost lacking in our present engineering literature so artless are we in our expression. It is to be hoped that the years of gigantic progress and advance in the science of engineering in which mere mechanical ideas have been foremost may now be surplanted with a higher, more forceful literature and with the beauty it possess enrich our engineering life.

PERSONALS.

H. R. Noack, president of Pierson, Roeding & Co., is in the Pacific Northwest.

J. M. Hunt, of Hunt, Mirk & Co., is at Tulare, accompanied by K. G. Dunn.

H. A. Lardner, Pacific Coast manager for J. G. White & Co., is leaving for a Northwestern trip.

J. E. Poingdestre, the Marysville district manager of the Pacific Gas & Electric Company is at San Francisco.

E. C. Ekstromer, Northwest manager for the Van Emon Elevator Company at Vancouver, B. C., is at San Francisco.

A. F. Hockenbeamer, vice-president of the Pacific Gas & Electric Company, has returned to San Francisco after an extensive Eastern trip.

A. Emory Wishon, assistant general manager of the San Joaquin Light and Power Company, with headquarters at Bakersfield, is at San Francisco.

F. G. Baum, of F. G. Baum & Co., who acts as consulting engineer for the Pacific Gas & Electric Company and other large corporations, is at Los Angeles.

J. R. Bibbins is at San Francisco from Chicago to act as chief assistant to Bion J. Arnold in his investigations of the electric traction problems of the city.

H. M. Cooper, manager of the Placer District of the Pacific Gas and Electric Company, with headquarters at East Auburn, was a recent San Francisco visitor.

Wallace W. Briggs, assistant sales manager of the Westinghouse Electric & Manufacturing Company, has been spending a few days at Los Angeles on business.

A. H. Babcock, chief electrical engineer of the Southern Pacific Company, is in the East on business connected with the extension of the company's electric traction lines.

W. E. Mitchell, formerly with the construction department of the General Electric Company's San Francisco office, has joined James Mitchell of New York City in engineering work.

A. J. Myers, the representative of the Wagner Electric Manufactuing Company, for California and Arizona, is at St. Louis, attending the regular annual meeting of the company's district sales managers.

Sidney J. Carr, who was formerly connected with the sales department of the Westinghouse Electric & Manufacturing Company's San Francisco office, is now associated with the Hawaiian Electric Company, Ltd.

J. Q. Brown, chief engineer and purchasing agent for the Oakland Railway Company, is in the East on business connected with the purchase of some new equipment, presumably for the power plant end of the system.

Guy E. Tripp has been elected chairman of the board of directors of the Westinghouse Electric & Manufacturing Company. He is an engineer well known in Seattle as one of the vice-presidents of the Stone & Webster engineering firm.

John Fulton of the Oregon Agricultural College is prepared to give a course in highway chemistry the first of its kind to be offered by any college. The course treats of the various components used in modern highway construction.

T. J. Stacey, vice-president and secretary of the Electric Appliance Company, of Chicago, left on the steamer Mongolia last Tuesday for Honolulu. He was accompanied by his wife and daughter. Their round trip will occupy a month.

James L. Raymur, the Water Commissioner of Victoria, B. C., has arrived at San Francisco for a short stay, with his wife and daughter. As the official in charge of the water works of his city, Raymur is responsible for the contract amounting to $1,116,000 that has just been signed by the Westholme Lumber Company for the construction of the new Sooke Lake water supply system.

Irving H. Sherwood, electric and mechanical engineer, formerly engaged in numerous power enterprises of the Northwest, is now a member of the firm of William S. Turner & Co., consulting engineers, Portland, Ore.

John Reed, civil and hydraulic engineer, formerly with the firm of Joseph H. Sands & Co., Roanoke, Va., as supervising engineer, is now a member of the firm of William S. Turner & Co., consulting engineers, Portland, Ore.

Fred T. Mumma, who has been with the construction department of the General Electric Company's San Francisco office, will leave February 1, to go into the general contracting business for himself. At first his headquarters will be at 5120 Grove street, Oakland.

P. L. Shuffleton, who is representing Stone & Webster in California, in connection with the work in progress on the Big Creek development, is a recent arrival at San Francisco. J. B. Lukes, who represents the firm at Reno, Nev., was also in the city during the past week.

E. N. Sanderson, H. Hobart Porter and Francis Blossom, all members of the New York firm of Sanderson & Porter, are in the Pacific Northwest on an inspection tour. It is expected that they will accompany Wynn Meredith, the Pacific Coast manager of the firm, to San Francisco during the first week in February.

H. M. Dougherty of J. G. White & Co.'s staff, who has headquarters at Los Angeles as superintendent of construction on the Midway Gas Company's proposed pipe line for natural gas, has been spending a few days at San Francisco. W. E. Barrett, the gas engineer of J. G. White & Co., who is also stationed at Los Angeles, has gone to New York for a conference on the details of the Midway Gas project.

ELECTRICAL CONTRACTORS' NOTES.

Hetty Bros. were awarded the electric wiring on the German House, for $6500.

C. V. Schneider, manager of the Electric Supply Company, of Sacramento, was in San Francisco last Thursday on business.

The General Electric Construction Company were awarded wiring of a warehouse for H. Levi at Fifteenth and Kansas streets.

H. B. Woodill, of the Woodill-Hulse Electric Company, Los Angeles, has been appointed Statesman for the Sons of Jove in the South.

Seth Cohn, proprietor of the Atlas Electric Company, of San Mateo, was in San Francisco last Friday. Mr. Cohn is starting a San Francisco office in the Hearst building.

The local branch of the California State Association of Electrical Contractors has filed a protest with the Board of Works against doing any more of the electrical work on the city and county hospital, San Francisco, by day labor.

The estimate on the electric wiring for the Sacramento Armory ran from $1945 to $3250. It is doubtful if the building will go ahead as bids for the entire contract exceeded the amount set aside, by $7428, the lowest bid being $107,438.

Judge Murasky ruled against the Civil Service Commissioners in the cases of Jones and Pendacook, two of the old inspectors of the Department of Electricity who were displaced by the McCarthy administration on trivial charges. As both men are old employes and good inspectors their friends are pleased to hear of the decision in their favor.

OREGON ELECTRICAL CONTRACTORS.

Oregon members of the National Electrical Contractors' Association held a preliminary meeting recently to perfect a State association. Members were present from all principal towns in Oregon. Fred D. Webber, State electrical inspector, acted as chairman. Committees were appointed on constitution and by-laws and membership. The objects of the association are: Fostering trade among the electrical contractors and the promotion of sociability among members.

INDUSTRIAL

WESTINGHOUSE ALTERNATING CURRENT GENERATORS

Waterwheel, alternating current generators of both the vertical and horizontal types are built by the Westinghouse Company. Machines of this type aggregating in capacity over three-quarters of a million kilo-volt amperes have been built by the company, and are in active successful operation.

The speeds of waterwheel generators of a given capacity operating under different conditions may vary so widely that a considerable range must be covered by a line of generators for waterwheel drive. These conditions are entirely unlike those affecting engine driven generators which are built for but a few fairly well standardized speeds. It is, therefore, impossible for the manufacturer to have a complete design for every combination of capacity and speed that may be required, and it is not good engineering practice to use one or two types of rotor construction for machines for the entire range of speed. So the Westinghouse Company has developed numerous types of rotor construction, each one proven in service and standardized.

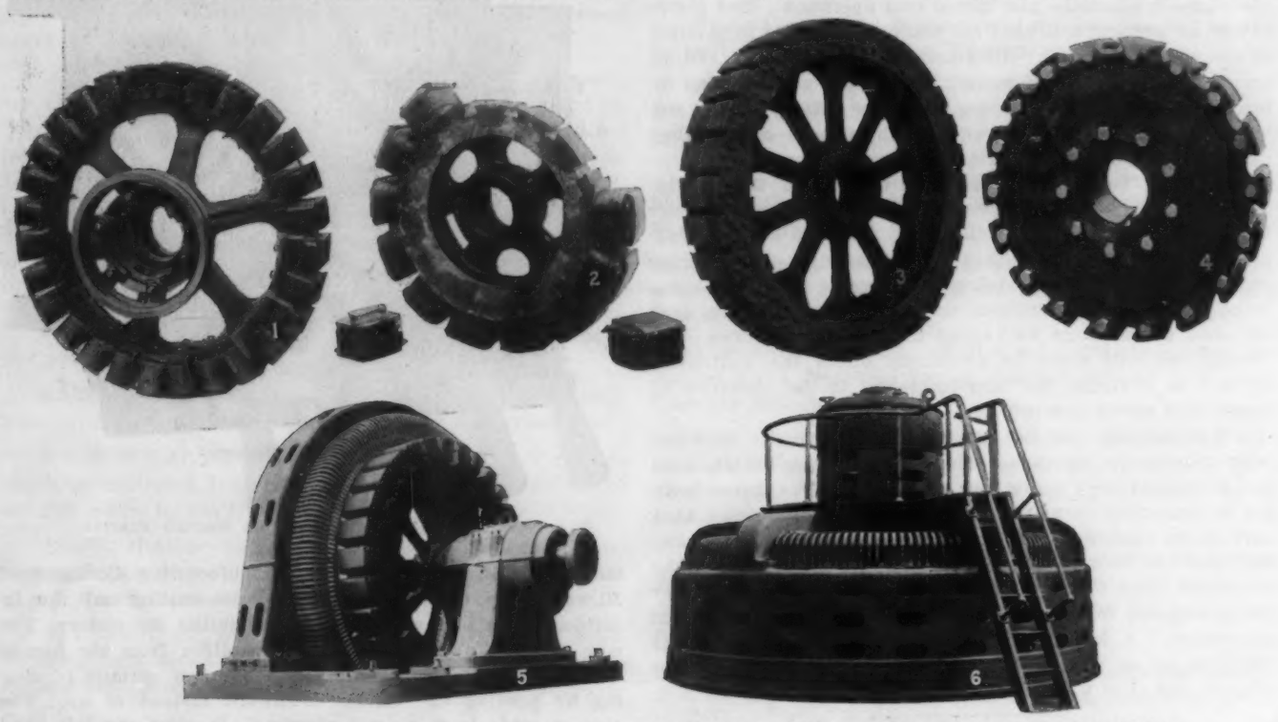


Fig. 1. Waterwheel Generator Rotor; Cast Spider Bolted Poles. Fig. 2. Waterwheel Generator Rotor; Cast Spider Dovetailed Poles. Fig. 3. Waterwheel Generator Rotor; Laminated Rim and Dovetailed Poles. Fig. 4. Complete Waterwheel Generator Rotor; Plate Spider and Dovetailed Poles. Steel Plate Waterwheel Generator Rotor. Horizontal Westinghouse Waterwheel Generator; Frame Shifted Over, Exposing Rotor. Fig. 5. Frame Showing Armature Windings for Westinghouse Horizontal Waterwheel Generators. Fig. 6. Vertical Westinghouse Waterwheel Generator.

Standard Westinghouse waterwheel generators are regularly wound for any of the following voltages: 240, 480, 600, 1200 and 2400. Those of 500 k.v.a capacity and larger are also standardized for 6600 volts. Two-phase or three-phase windings are standard. For single-phase service, generators are supplied having three-phase windings and the single-phase load is carried by any two leads of the three-phase winding. When so connected, a three-phase generator is guaranteed to carry a single-phase load equal to 70 per cent of its three-phase rating.

As previously suggested, it is not consistent with economical and safe construction to use rotors of the same general design for an entire line of waterwheel generators, due to the wide ranges of speed and capacity to be covered. In general the centrifugal stresses are very much higher in rotors turning at high peripheral speeds than in rotors turning at low peripheral speeds. This condition is recognized by the Westinghouse Company, and in developing the line of waterwheel generators, it was found expedient to adopt rotor construction of several different forms. Each is inherently adapted for certain speed and capacity ranges as indicated in the following schedule of the principal types.

The construction of Fig. 1 in which the poles are bolted to the rim of cast iron or steel spider, is adapted for the lowest peripheral speeds such as ordinarily obtain with very low heads of water.

Fig. 2 shows a construction wherein poles are dovetailed to the rim of a cast spider, which is adapted for almost any speed but is limited in its application because of the difficulty of promptly obtaining castings of large diameter. Cast steel spiders are usually required for this construction.

In a construction, Fig. 3, adapted for rotors of large diameter and high speeds a laminated rim is dovetailed to a cross spider and the poles are dovetailed to the rim. This construction is adapted for large diameters and high speeds. A cast steel spider, or the solid plate spider described below, would be satisfactory for these conditions provided the plates or castings of the requisite diameter could be readily obtained. The use of such large castings are, if possible, avoided as they may introduce delays in manufacture.

In another construction that is adapted for the highest speeds, the spider is formed of laminations punched from sheet steel. The maximum diameter of such a rotor is determined by the maximum diameter of laminations that it is

feasible to punch. Over 600 generators having rotors of this type are giving satisfactory service.

Rolled steel plates form spiders of the construction of Fig. 4. The poles are dovetailed to the spider. This arrangement is adapted for the highest speeds. It is evident that it would not be possible to increase the strength of this construction as the rolled steel is absolutely uniform in texture. It is moreover, readily-obtainable, merchant material.

Poles for all Westinghouse waterwheel generators are laminated. The field coils are retained on the poles by overhanging pole tips, and, where the stresses are high, by extra coil supports riveted to the sides of the poles.

Cast iron frames of modified box section, designed for maximum stiffness, support the punchings that form the armature structures of horizontal generators as shown in Fig. 5. Ventilating finger plates are inserted at intervals between the stator laminations and insure cool operation. End plates of cast or wrought iron bind the laminations firmly in position in the stator structure. All armature slots are open and all armature coils are form wound, thoroughly insulated and interchangeable. The armature coils are effectively braced, wherever necessary, at the ends of the frames so that they cannot distort under the action of excessive currents.

Open or ventilating end-bells are used on the smaller Westinghouse horizontal generators. These end-bells are built up from mild steel sections and are rigid and unbreakable. At the same time they are extremely open, assuring that air circulation and cooling air currents will not be materially obstructed. Enclosing end-bells are successfully used on some of the large high-speed horizontal generators. Enclosing end-bells serve to effectively direct the ventilating air and to minimize the hum incidental to the operation of large, high speed generators.

Westinghouse vertical generators are usually provided with two guide bearings. The bearings are babbit lined and lubricated by a continuous flow of oil. The thrust bearing is ordinarily furnished by the waterwheel builder as a part of his equipment, but when the Westinghouse Company furnishes the thrust bearing, it is mounted on the top of the generator. See Fig. 6. A mechanical or motor-driven rotary pump supplies forced lubrication for Westinghouse vertical generators. A bed plate is provided with each generator which is set on the foundation. The generator is accurately aligned, and then firmly clamped to this plate.

TRADE NOTES.

The General Electric Company reports the sale of a centrifugal air compressor to the Great Western Smelting & Refining Company of San Francisco for use with an oil-fired furnace.

The Wagner Electric Manufacturing Company of St. Louis, announce the removal of their San Francisco office to the new Rialto Building, with store entrance 110 New Montgomery street, to continue in charge of Mr. A. J. Myers. The telephone number, Douglass 2139, will be unchanged.

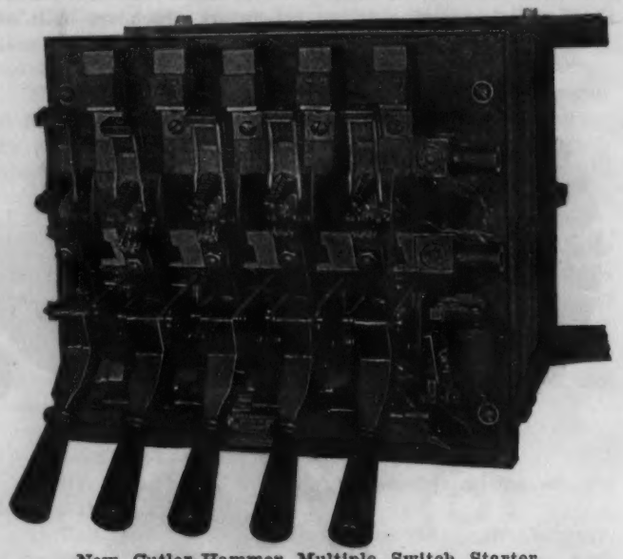
William S. Turner, consulting engineer, of Portland, Ore., has just associated with himself two engineers of note, John Reed, civil and hydraulic engineer, and Irving H. Sherwood, electric and mechanical engineer. A partnership under the firm name of William S. Turner & Co. has been formed to undertake a general engineering practice.

After lengthy consideration, the contracts for the equipment of the San Francisco hydroelectric plant in connection with the Los Angeles Aqueduct, were recently awarded. The Westinghouse Electric & Manufacturing Company secured the three 8,700-kw. generators, which are to have a possible overload capacity of 10,000 kw. each. The Westinghouse Company was also awarded the transformer contract amounting to nearly $100,000. The contract for the water wheels was awarded to the Union Iron Works of San Francisco. The water wheels will be of very heavy construction, the main bearings being 18½ inches in diameter.

The Hawaiian Electric Company, Ltd., which holds the joint agency for the Westinghouse Electric Manufacturing Company and the Pelton Water Wheel Company in the Hawaiian Islands, has secured a contract for a hydroelectric installation from the Maui Agricultural Association. The specifications call for a 1,000-k.v.a. generating set consisting of a 2400-volt Westinghouse generator direct connected to a Pelton-Francis turbine equipped with a Pelton oil pressure governor and operating at 720 r.p.m.

NEW MULTIPLE SWITCH STARTING RHEOSTATS.

For large motors because of the larger currents, starting rheostats of the ordinary sliding contact type are not well adapted. Multiple switch starters, one of a new line manufactured by the Cutler-Hamner Manufacturing Company of Milwaukee is illustrated, are used for cutting out the individual steps of resistance for accelerating the motors. The new switches used on these starters differ from the former types used in that a toggle joint operation permits of closing by pushing the handle downward instead of up. The contact made is quick and absolute. In start the left hand switch is closed first, then the second, third, etc., allowing a second or two between. Each switch, by means of metal stops near the handles, holds the switch before it, in place. When the last switch is closed the No-Voltage Release Magnet holds them all in contact and the entire resistance is short-circuited. The switches cannot be closed out of order and two or three switches, for instance, cannot be closed and the others left open. Releasing the hand from any handle except the last causes all switches to open. The motor cannot run with resistance in the circuit and the resistance is, therefore, also protected from overheating. Overload Release is also included in the various types made.



New Cutler-Hammer Multiple Switch Starter.

NEW CATALOGUES.

Sprague Electric Works of the General Electric Company has issued Bulletin 239 which illustrates and describes the Sprague full automatic push button control system for the operation of newspaper presses.

Catalog A from Smith-Booth-Usher Company of Los Angeles is a 576 page volume listing and describing the large line of machinery carried in stock. This includes steam boilers, engines, pumps, air compressors, distillate engines, windmills, transmission machinery, machine tools, mining machinery, concrete and brick machinery, pipe, casings, fittings and valves. The index is most complete, facilitating the purchasers' use.

NEWS NOTES

INCORPORATIONS.

MEDFORD, ORE.—California-Oregon Power Company; capital stock, $10,000,000.

LOS ANGELES, CAL.—Pacific Engineering Company; incorporators, Donald W. Wilson, Ben G. Rowan, A. A. Wilson, R. N. Rogers; capital stock, $10,000; subscribed, $500.

SANTA FE, N. M.—Luna County Telephone Association, of Deming, has been granted a charter, with capital stock of $25,000. The incorporators are: Hugh Ramsey, F. A. L. Taylor, A. L. Taylor. A. A. Tempke is agent, with office at Deming. Will build and operate lines of communication between towns, cities and villages of Luna County.

LOS ANGELES, CAL.—Upland Foothill Water Company has been organized for the purpose of developing water in Ridge Canyon section for irrigation purposes. Capitalized for $89,000. Incorporators are: J. P. Wedel, G. A. Hanson, D. D. Tempe, William Rohrig, C. E. Searles, O. W. Kankel, R. N. Leahy, A. J. Smith, O. L. Galbreth, S. P. Wieger, J. J. Atwood and J. D Wilson.

ILLUMINATION.

NEWPORT, CAL.—The matter of voting bonds for light and power will be ready for action again on June 6th.

CATHLAMET, WASH.—The Council has passed an ordinance granting to J. D. Haycock an electric light franchise.

COLTON, CAL.—The Southern California Gas Company, which is erecting a $75,000 gas plant, bid in the franchise to lay gas mains in the city of Colton

BOISE, IDAHO—The Boise Gas Light Company will increase the size of its plant four times and lay about 10 miles of new mains, it expects to spend $75,000.

ELLENSBURG, WASH.—J. A. Crimp, City Clerk, is advertising for bids on 124 three-cluster light poles, with shade holders and foundation bolts. Bids will be opened February 5. 1912.

ABERDEEN, WASH.—The City Council has accepted the Grays Harbor Railway and Light Company's offer to add 295 tungsten lights to the city's lighting system at $2.25 a month for each light.

PORT TOWNSEND, WASH.—The Council has passed an ordinance granting to the Olympia Power Company the authority to erect poles and wires across certain streets in the city for the purpose of transmitting electric current.

ELLENSBURG, WASH.—S. Bornstein of Seattle has made application for a 50-year gas franchise. Mr. Bornstein offers to pay the city a gradually increasing percentage of the gross receipts, starting with one-half of 1 per cent and increasing to 2 per cent.

LYNDEN, WASH.—Albert F. Cooke, said to represent Smith, Cary & Chase, Toronto engineers, has applied to the City Council for an electric light franchise. W. H. Waples, of Waples Shingle Mill, and at present furnishing the city with light, is also asking for a new lighting contract. Both applications have been before the Council some time.

OAKLAND, CAL.—The Mono Power Company of Oakland yesterday filed a certificate of creation of bonded indebtedness in the sum of $2,500,000. The bonds are 30-year 6-per cent interest, payable semi-annually, and redeemable at 105 per cent of their par value, with accrued interest, on and after December 15, 1916. The company is incorporated for $3,000,000, with 30,000 shares of a par value of $100 each. The directors are J. J. Quinn, Leon M. Hall, I. H. Clay, Fred L. Dreher and H. A. Mosher.

TRANSPORTATION.

CALDWEL, IDAHO—The interurban electric road will be extended this year from Caldwell to Weiser.

TWIN FALLS, IDAHO—Work has started on an electric line from Gooding to Oakley, via Jerome and Milner.

KLAMATH, ORE.—It is reported that an electric line will be built this year to connect Klamath with Lakeview.

NEWBERG, ORE.—The Southern Pacific and Oregon Electric have secured a franchise to lay a single-track electric road on First street.

VANCOUVER, B. C.—The British Columbia Railway has announced that it will double the size of its production plant at a cost of $4,000,000.

SALEM, ORE.—An electric line from here to Mehama seems assured. It is estimated the line will cost $301,000 and will be 17½ miles in length.

LOS ANGELES, CAL.—E. D. Goode, railroad builder, has applied for a franchise for an electric railroad to connect Glendale with Griffith Park.

FERNIE, B. C.—Application has been made to the government for permission to construct an electric railway from Cowley to Crow's Nest Lake, a distance of 25 miles. W. A. Beebe is acting for the applicants.

LEBANON, ORE.—Engineering headquarters have been established here by E. S. Clark and a crew of ten assistants from Walla Walla, who will make a survey for an electric road up the South Fork of the Santiam.

LOS ANGELES, CAL.—The Council has granted permission for the Santa Monica airline to be changed from steam to electric. Life of franchise will be limited to twenty-one years and transfer arrangement has been improved.

VANCOUVER, B. C.—The British Columbia Railway has announced that it will double the size of its production plant this year, so that by January 1, 1913, 105,000 horsepower will be available. The work will cost from three to four millions.

PASADENA, CAL.—The Southern Pacific Railroad Company has applied to the City Council for a franchise to electrify its system from the Southern Pacific Depot on Colorado street along Broadway to the city limits, The request will be granted.

LODI, CAL.—Surveyors have been running lines in the hills between Lockeford and Jackson for several weeks, and there are indications that the Central California Traction Company may extend its proposed branch line to Lockeford on to Jackson and possibly to San Andreas.

STOCKTON, CAL.—The amended articles of incorporation of the Oakland, Antioch and Electric Railway Company have been filed and reports are that the work of constructing the railroad will commence in the near future. The company, which is being financed by San Francisco capitalists, is preparing to run a line from Oakland to Sacramento through Alameda, Contra Costa, Solano, Yolo and Sacramento counties, with a branch line running between Antioch and this city. The entire length of the road will be approximately 130 miles.

DALLAS, ORE.—At a meeting of the Dallas Commercial Club last night, steps were taken to join in the movement being put forward to get the proposed electric line to McMinnville extended through Polk and Benton counties to Corvallis and then on to Eugene.

STOCKTON, CAL.—The Tidewater and Southern Railroad has been granted a franchise to operate an electric road over Pilgrim street from South street to Scotas street and along Scotts avenue to East street. It provides for double tracks, the use of T-rails and the sprinkling of the streets on which it runs. It is required that the railroad be in operation within two years.

SEATTLE, WASH.—Three bids were received by the Board of Public Works for the construction of a municipal street railway 4½ miles long, double track except 3000 feet at the north end. Jahn Construction Company bid $148,941; Graf Construction Company, $163,000, and Stillwell Bros., $175,000. First two want cash, but the last named accepts bonds if such are held to be legal.

RICHMOND, CAL.—Engineers for the United Properties Company have begun making a survey for the double tracks of the East Shore Suburban Railway between this place and Oakland. Shortly after the traction line was purchased by the $200,000,000 corporation and combined with the Key Route and Oakland Traction Company, it was promised that the entire line would soon be double-tracked and a faster schedule provided.

PORTLAND, ORE.—The Southern Pacific will soon commence the electrification of the Fourth-street line and a part of the Yamhill division as far south as McMinnville, embracing approximately 100 miles of tracks. D. W. Campbell, general superintendent of the lines in Oregon and Northern California, states that plans for all the work have been completed, and as soon as the necessary franchises are obtained in Hillsboro and in Portland, actual work will be started.

TRANSMISSION.

STEVENSON, WASH.—The Northwestern Electric Company has been granted a franchise to erect electric power lines on county roads.

TACOMA, WASH.—The Seattle-Tacoma Power Company will put up a second high tension line to the Tacoma Smelter at an estimated cost of $10,000.

BROWNSVILLE, ORE.—The Oregon Power Company is extending its lines on Walnut avenue and Main street. More work of the same kind will follow.

LIBBY, MONT.—The Kootenai Falls power project is assured, the final steps having been taken by the backers. The total cost of plant is estimated at $6,000,000, with generation of 100,000 horsepower.

SAN FRANCISCO, CAL.—The Great Western Power Company's 11,000-volt submarine cable connecting San Francisco with the Oakland side of the bay was successfully laid January 23d from a steel barge built for the purpose.

FREEWATER, ORE.—The construction of 10 miles of power line costing $9500, and supplying 15 customers, with a total of 108 horsepower, has just been authorized by the main office of the Pacific Power and Light Company in Portland.

SAN FRANCISCO, CAL.—The Great Western Power Company has been granted a temporary permit for the use of a reservoir and power site on the National forest and public lands in connection with its Feather River project. This is the site of the Big Meadows Reservoir now under construction.

PORT TOWNSEND, WASH.—The Irondale Electric and Power Company has been granted the desired franchise to act as distributor of power from the Olympic Power Company in a large section of country extending from the Clallam County line through practically all the settlements in the county lying north of Quilcone.

BELLINGHAM, WASH.—Smith, Kerry & Chace, a Toronto firm of capitalists, have bought land west of here for a power plant site. Water rights on the middle fork of the Nooksack River have been acquired by the company and it is said power will be generated for the use of the big Balfour-Guthrie cement plant, now being erected.

LYLE, WASH.—Judge H. E. McKenney has decided the case of the Northwest Electric Company against the squaw Emma Dave and other claimants. The decision held that the deposit of the petitioner was ample for all damages that might accrue, and the Northwest Electric Company could proceed to develop the water power of the Big Klickitat River.

TELEPHONE AND TELEGRAPH.

PULLMAN, WASH.—A new telephone franchise has been granted the company here.

BOISE, IDAHO—Mountain States Telephone and Telegraph Company will spend $300,000 rehabilitating its system.

OLYMPIA, WASH.—The Postal Telegraph Company is making preparations to rebuild its line between Olympia and Tenino.

HOQUIAM, WASH.—Telephone lines between here and Moclips and Pacific Beach, also between Aberdeen and Cohasset, are being talked of.

SOUTH PASADENA, CAL.—A. B. Cass, president of the Home Telephone Company, announces that a separate exchange will be provided in the near future.

RED BLUFF, CAL.—The Tehama County Telephone Company has decided to extend its lines further into the country districts and to continue work on the long-distance connections.

CHEHALIS, WASH.—Permission has been granted by the Board to set telephone posts and string wires over the county roads from Morton to Riffe, in accordance with application made by the Highland Valley Telephone Company, a new concern which has just organized. E. C. Coombs of Morton is the president.

POMONA, CAL.—Because of the large increase in its long-distance business, during the last few months, there has been installed at the local Home Telephone Company's building a new "four-position" long-distance switchboard. The facilities of the long-distance department of the company have been doubled by the addition of this new equipment. The long-distance office has been moved to the first floor of the building north of the First National Bank.

WATERWORKS.

HOLTVILLE, CAL.—The city has incurred a bonded indebtedness of $8000 for completing water works system.

WHITTIER, CAL.—The City Trustees have decided to spend $11,000 on improvement of the city water system.

GRANTS PASS, ORE.—The Crystal Springs Water Company will extend a pipe line from the mountains three miles north of the city into Grants Pass.

MEDFORD, ORE.—The Jacobson-Bade Company has been awarded the contract for putting in the entire distributing system for the Jacksonville new water system. Price to be paid for the work is $27,000.